Information Circular 86-2

ELEVENTH ANNUAL REVIEW OF ACTIVITIES

Project Resumés

1986

Edited by

Shasta A. Abbott

Mineral Resources Division
Department of Natural Resources
  and Energy
New Brunswick

1986

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BATHURST REGIONAL OFFICE

ACTIVITIES OF THE BATHURST REGIONAL OFFICE

J.L. Davies, Regional Geologist

The staff of the Bathurst Regional Office consists of J.L. Davies (acting Regional Geologist), J.A. MacIntosh (Assistant Regional Geologist), Sharon McKinnon (Administrative Services Officer), and André LeBlanc and Maurice Belland (Engineering Technicians). J.L. Davies assumed the position of Director of Geological Surveys Branch in 1986, and is presently dividing his time between the Bathurst and Fredericton offices. It is hoped that the Regional Geologist (North) position will be filled by the end of 1986. D.M. Burton, G.R. Philpott, and R. Wilson are contract geologists responsible for projects funded through the New Brunswick-Canada Mineral Development Agreement (MDA). T.G. Mersereau assisted in the MDA-funded geocompilation project. Most of the field work and data collection conducted from the Bathurst Regional Office utilizes MDA funds. Provincial budgets alone are not sufficient to sustain large projects.

FEDERAL-PROVINCIAL (MDA) PROJECTS

D.M. Burton and G.R. Philpott combined forces to assess the gold deposit potential of the Lower Devonian (and Upper Silurian?) volcanic rocks along the Jacquet River Fault (page 5). R. Wilson initiated geological mapping in the New Denmark area of northwestern New Brunswick (page 61). A contract was awarded to the Geology Department of the University of New Brunswick (UNB) to study the Heath Steele sulphide deposit (page 17). J.G. Torrance is the project coordinator. A.G. Pronk continued his surficial geological mapping in the Upsalquitch Forks region (page 65). The Geocompilation Project (page 10) managed by T.G. Mersereau, is underway, and is being combined with the preparation of a computerized mineral deposit file under the direction of D.G. Rose. Approximately 900 stream silt samples, collected in past years were analysed for antimony, arsenic, barium, and gold. The results of this work are expected to be published in 1987. The results of the analysis of stream silt samples from the Upsalquitch Forks (21 O/10) and Serpentine Lake (21 O/2) map areas were released during the summer of 1986.

PROVINCIAL PROJECTS

Geological Mapping:

J.A. MacIntosh resumed his work on the O-9 map area (scale one inch equals 1/4 mile) and has now completed all the field checking. The map report covering the area is in preparation.

Stream Silt Surveys:
P. Arsenault was contracted during 1986 to computerize all stream silt data gathered by the Geological Surveys Branch. Some 27 000 samples gathered from New Brunswick streams in the last 20 years or so, have been analysed for several metallic elements.

The results of the stream silt surveys in northwestern New Brunswick (parts of 21 N/2, N/6, N/7, N/8) and the California Lake map area (21 O/8) were released in 1986.

MINERAL DEPOSITS

R.R. Irrinki of the Fredericton office continued his study of metallic mineral deposits in the Bathurst-Newcastle area. During 1986 Mr. Irrinki compiled data on the Key Anacon deposit (page 11).

DIAMOND-DRILL CORE

A large amount of core was accepted from the Flat Landing Brook sulphide deposit in 1986. The core is part of an intensive drilling program carried out by Brunswick Mining and Smelting Corporation Ltd.

OTHER ACTIVITIES

André LeBlanc and Sharon McKinnon carried out work related to the claim staking and related activities associated with extensive gold exploration. Mr. LeBlanc continued his work of transferring claim data to new 1:50 000 base maps and keeping mineral exploration assessment index maps up to date. Mr. LeBlanc also carried out claim inspections in the field.

M. Belland continued his compilation of exploration assessment data, and assisted the Regional Geologist in coordinating mineral exploration activities and forestry operations. Work was also begun on compilation of 1:50 000 geology maps 21 O/9 (Tetagouche Lakes) and 21 P/5 (Nepisiguit Falls).

The Regional Geologist and his staff participated in career expositions in various high schools in the region. They have also conducted or assisted in field tours of the region for visiting geologists.

The Regional Geologist co-authored a paper with A.A. Ruitenberg dealing with gold deposits of New Brunswick. He also gave talks to a variety of organizations describing exploration for gold in New Brunswick.

Financial assistance was rendered to J.D. Greenough, St. Mary's University who is studying possible mantle-derived mafic rocks in New Brunswick.

J.A. MacIntosh and J.L. Davies assisted local authorities in the planning of the Petit Rocher Mining Interpretation Centre that was officially opened in June, 1986.

GEOLOGY, GEOCHEMISTRY, AND ECONOMIC POTENTIAL OF LOWER DEVONIAN VOLCANIC ROCKS ALONG THE JACQUET RIVER FAULT, NORTHERN NEW BRUNSWICK

D.M. Burton and G.R. Philpott, Project Geologists

Volcanic and sedimentary rocks of the Lower Devonian Dalhousie Group underlie a narrow (1-7 km) east-northeast trending belt that extends for 65 km from the village of Lorne to the Upsalquitch River in northern New Brunswick (Figure 1). The northern part of the belt comprises roughly equal proportions of mafic and felsic volcanic rocks whereas the southern part is dominated by mafic volcanic and sedimentary rocks (Figure 2). The Jacquet River Fault separates the northern and southern successions.

The northern succession is a bimodal suite of alternating rhyolitic and basaltic(?) tuffs and flows. Stratigraphic relationships are unclear due to the diversity of the pyroclastic units and the absence of marker horizons. Minor interbeds of fossiliferous sediment are present; however, these units cannot be traced on a regional scale. The most common rock types are felsic lapilli tuffs, flow-banded rhyolites, mafic lapilli tuffs, and amygdaloidal and massive flows.

The southern succession is dominated by mafic flows and agglomerates. The lowermost unit comprising amygdaloidal basalts, pillowed basalts, mafic agglomerates, and andesite is overlain by porphyritic basalt and mafic agglomerate. Pillowed flows were not previously recognized in the area. This sequence is overlain by porphyritic basalt and mafic agglomerate. Flow-banded rhyolites and felsic agglomerates that in part cap the mafic volcanic rocks, are, in turn, overlain by siltstones, mudstones, and fossiliferous limestone.

The current study is a one year MDA-sponsored program. The objectives of this program are:

1) to assess the economic potential of the volcanic belt by regional sampling and re-examination of mineral showings and trenches,

2) to determine the depositional environment of the volcanic rocks and identify any areas of subsequent hydrothermal activity, and

3) to determine the geochemical characteristics of the volcanic suite by means of comparative whole rock analysis.

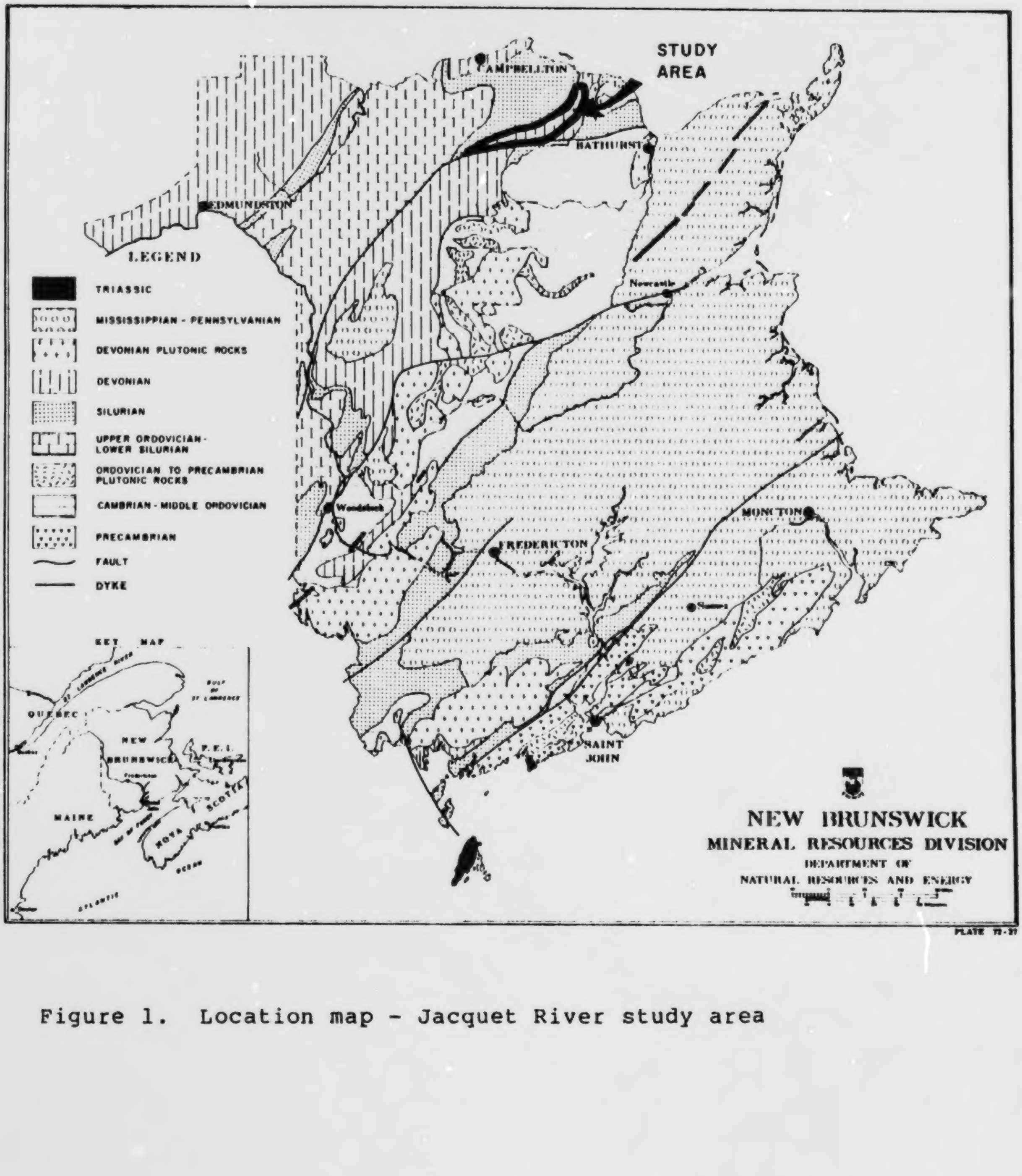


Figure 1. Location map - Jacquet River study area

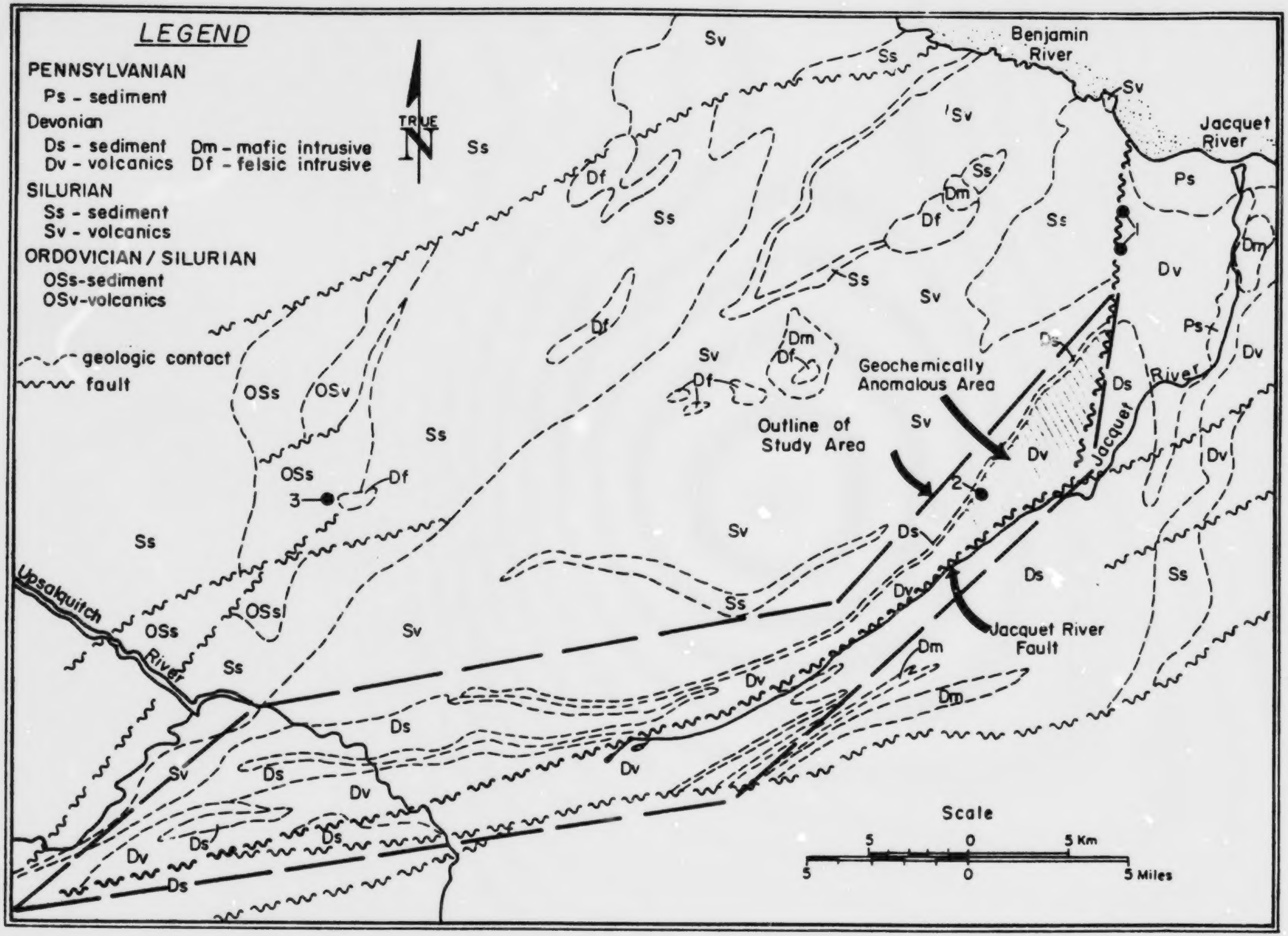


Figure 2. Generalized geology along the Jacquet River Fault (after Davies 1979). Mineral occurrences: 1. Nash Creek, 2. McNeil Brook, 3. Popelogan

The volcanic belt has not, until recently, been explored for gold. Possible environments favouring gold mineralization in the Jacquet River terrain include the following (Boyle 1979);

1) auriferous dykes, sills, and stocks

2) gold-silver veins, stockworks, etc. in fractures, faults, and shear zones

3) disseminated gold-silver in volcanic flows and associated volcaniclastic rocks

Highly anomalous base-metal contents (up to 110 ppm Cu, 2300 ppm Pb, and 8000 ppm Zn) were detected in stream silts taken from a number of streams that crosscut the volcanic stratigraphy in the north between McNeil Brook and Lower Jack Burns Lake (Boyle et al. 1966). Subsequent exploration led to the discovery of a number of minor base-metal occurrences; however, only the McNeil Brook Cu-Pb-Zn showing seemed to be of significance (Figure 2). Interest in the anomalous area faded when it became evident that the volcanic rocks were dominantly subaerial or shallow submarine and lacked massive sulphide horizons. High metal contents in the silts were attributed to manganese scavenging. A recent stream sediment survey (Geological Survey of Canada 1986) did not detect any comparable anomalies in the southwestern part of the study area.

Disseminated and fracture-filling sulphides are widespread throughout the geochemically anomalous zone, particularly within the felsic volcanic rocks (massive to flow-banded rhyolite and lapilli tuffs). Quartz-carbonate veining is the most frequently encountered alteration-related phenomenon in areas of high sulphide content (1-5%). Chloritization and sericitization are rarely encountered. In marked contrast, the mafic volcanic succession throughout the southern half of the study area is sparsely mineralized.

To date, approximately 300 rock samples have been submitted for minor- and trace-element analysis. Samples were selected on the basis of their sulphide content and/or alteration. These rocks are being analysed quantitatively for the following elements: Ag, As, Au, Bi, Ca, Cd, Co, Cr, Cu, Fe, Hg, K, Mn, Mo, Na, Ni, P, Pb, Sb, Se, Te, Ti, V, and Zn.

REFERENCES

DAVIES, J.L. 1979. Geological map of northern New Brunswick. New Brunswick Department of Natural Resources, Map NR-3.

BOYLE, R.W. 1979. The geochemistry of gold and its deposits. Geological Survey of Canada, Bulletin 280, 584 p.

BOYLE, R.W., TUPPER, W.M., LYNCH, J., FRIEDRICH, G., ZIAUDDIN, M., SHAFIQULLAH, M., CARTER, M. and BYGRAVE, K. 1966. Geochemistry of Pb, Zn, Cu, As, Sb, Mo, Sn, W, Ag, Ni, Co, Cr, Ba, and Mn in the waters and stream sediments of the Bathurst-Jacquet River district, New Brunswick. Geological Survey of Canada, Paper 65-42, 50 p.

GEOLOGICAL SURVEY OF CANADA 1986. Regional stream sediment and water geochemical reconnaissance data, New Brunswick, 1985. Geological Survey of Canada, Open File 1211, NGR 76-1985, (parts of NTS 21 O/9, 10, 11, 13, 14, 15, 16; 22 B/1, 2), 90 p. and 25 maps.

GEOSCIENCE COMPILATION PROJECT

Two contracts were awarded under the MDA in mid-1986 to K.D.A. Whaley and Three-D Geoconsultants Limited to compile the mineral exploration assessment data on 1:10 000 maps covering the California Lake Map area (21 O/8).

Later in 1986, depending on the progress of the first contracts, tenders will be invited for the compilation on the Nepisiquit Falls map area (21 P/5). Base maps for the Upsalquitch Forks map area (21 O/10) are in preparation.

To augment this program, D.G. Rose was hired to design and develop a computerized mineral deposit data file for New Brunswick.

KEY ANACON SULPHIDE DEPOSIT STUDY

R.R. Irrinki, Metallic Minerals Geologist

The Key Anacon sulphide deposit is the second to be evaluated as part of a provincially-funded study being carried out on important base-metal deposits in northern New Brunswick. The deposit consists of at least four mineralized zones occurring as northwest-trending en echelon lenses within a 3 km long sulphide-bearing sequence. These zones from southeast to northwest are: Zone 1, Zone 2, Zone 3, and Copper Zone (Figure 3). The geological reserves on this deposit have been estimated by Department of Natural Resources and Energy personnel and are intended for internal use only.

ZONE 1

Zone 1, lying about 800 feet (240 m) southeast of the Zone 2 shaft, was outlined by 20 surface diamond-drill holes on 200 foot (61 m) spacings. The zone has a length of 1600 feet (490 m), a thickness of 7 feet (2 m), and extends to a depth of 600 feet (180 m). The main minerals are pyrite, sphalerite, galena, and pyrrhotite. A plan with surface projections, cross sections, and a longitudinal section suggests probable reserves of 372 000 tons (337 000 tonnes) grading 1.05% Pb, 3.86% Zn, and 1.25 oz./ton (42.86 g/t) Ag.

ZONE 2

Zone 2 is the only zone that has been sufficiently investigated by underground drilling. Nine levels were developed to a depth of 1450 feet (440 m) and at a level spacing of 150 feet (45 m); 229 holes were drilled from these levels. During June and July, 1986, Paul Rennick (Department of Natural Resources and Energy) relogged most of this core and systematically collected some 500 representative samples. Out of these samples, 75 regular thin sections and 35 polished thin sections were studied. These samples and thin sections are available for public viewing.

Zone 2 consists of at least three lenses that occur in sharp contact with mafic volcanic rocks in the hanging wall, and is closely associated with the quartzose sedimentary rocks and intercalated felsic volcanic rocks. The zone has a length of 400 feet (120 m), a width of 250 feet (75 m), and extends to a depth of 1300 feet (400 m).

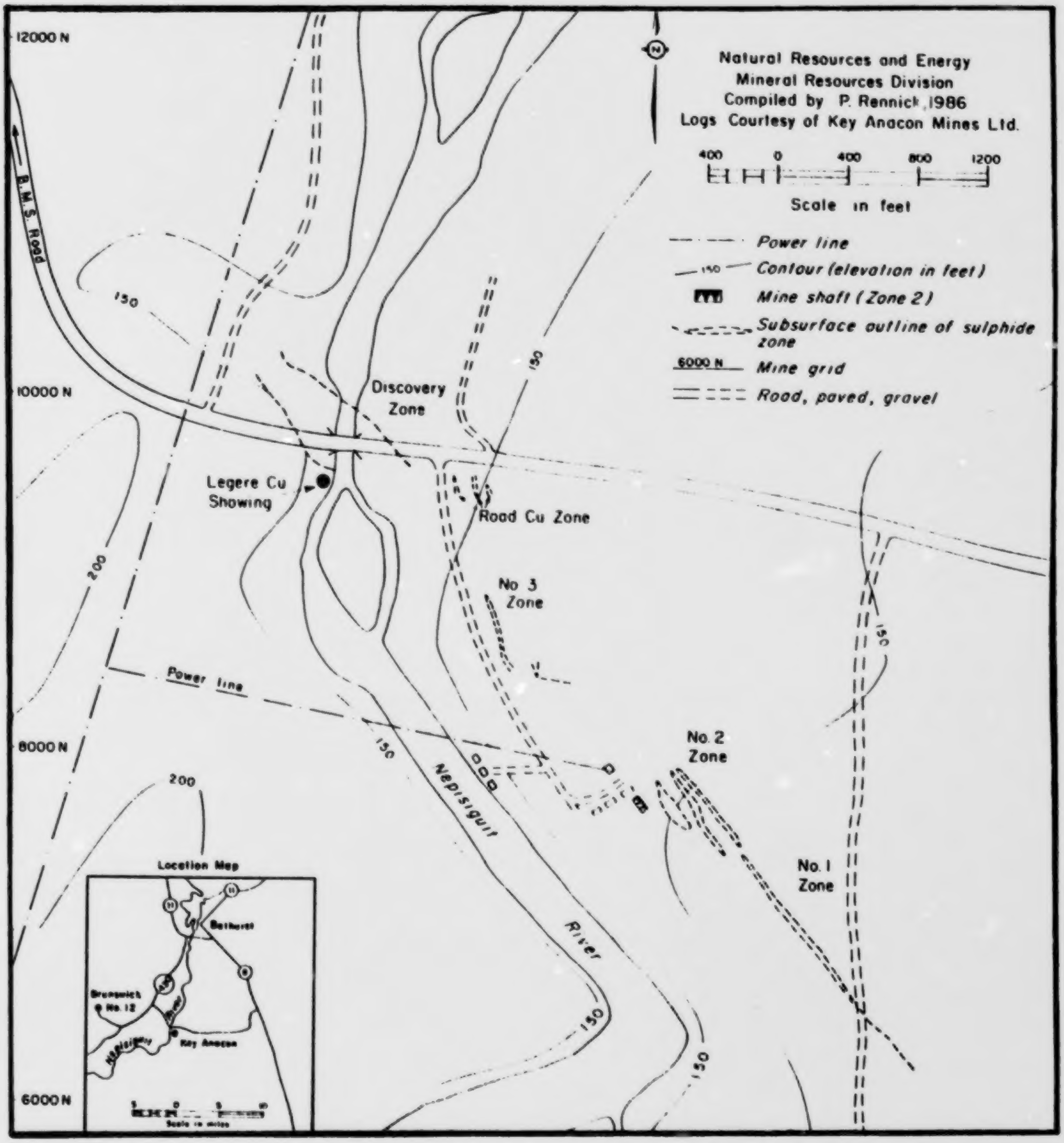


Figure 3. Key Anacon sulphide zones

Pyrite - chalcopyrite, pyrite - sphalerite - galena, and pyrrhotite - pyrite - sphalerite - galena are the dominant assemblages, but arsenopyrite and tetrahedrite occur locally. In low-grade Pb - Zn zones, pyrite is generally massive and commonly colloform, whereas zinc - lead rich parts are banded and/or brecciated. Pyrite - chalcopyrite generally occurs in disseminations and banded sulphides.

Although F_1 folds are reflected in the sections (Figure 4), their exact orientation is not known. The sulphides and the surrounding lithologies are folded by F_2 folds with wavelengths varying from a centimetre to several metres. The F_2 macroscopic folds, reflected both in sections and level plans (Figures 4, 5), have northwest-trending, steep-dipping axial planes, steep (greater than 70°) southeast-plunging axes and tight limbs. Mesoscopic F_2 folds with similar geometry and orientation can be observed on the outcrops along the Nepisiguit River. Faults indicated by shearing and brecciation also occur within the zone.

Copper, lead, zinc, and silver in situ geological reserves were estimated on Zone 2 based on sections at 50 foot (15 m) intervals and plans at 150 foot (45 m) intervals (Table 1). These were grouped into high-grade mineralization containing greater than 10% Cu+Pb+Zn, low-grade mineralization containing 5 to 10% Cu+Pb+Zn, and copper mineralization containing greater than 1% Cu. Gold values varying from 0.03 to 0.16 oz./ton (1.03 to 5.49 g/t) are generally associated with the pyrite-chalcopyrite (copper) horizon. Not enough samples assayed for gold values are available to estimate the average gold content of the pyrite-chalcopyrite horizon.

ZONE 3

Zone 3, lying about 700 feet (210 m) northwest of the Zone 2 shaft, was outlined by 11 surface drill holes spaced at 100 foot (30 m) intervals. The zone has a length of 1600 feet (490 m), approximate thickness of 8 feet (2.5 m), and extends to a depth of 600 feet (180 m). A plan with surface projections, cross sections, and a longitudinal section suggest probable geological reserves of 87 000 tons (79 000 tonnes) grading 1.69% Pb, 7.40% Zn, and 1.47 oz./ton (50.40 g/t) Ag.

COPPER ZONE

The copper zone includes the Road Copper and Discovery zones (Figure 3). The Discovery Zone, lying 3200 feet (975 m) northwest of the Zone 2 shaft, is exposed at the surface (Leger showing) on the western bank of the Nepisiguit River about 200 feet (60 m) southwest of the bridge. Some of the 15 holes drilled on this zone intersected about 2% Cu over 2 foot (0.6 m) to 5 foot (1.5 m) core lengths.

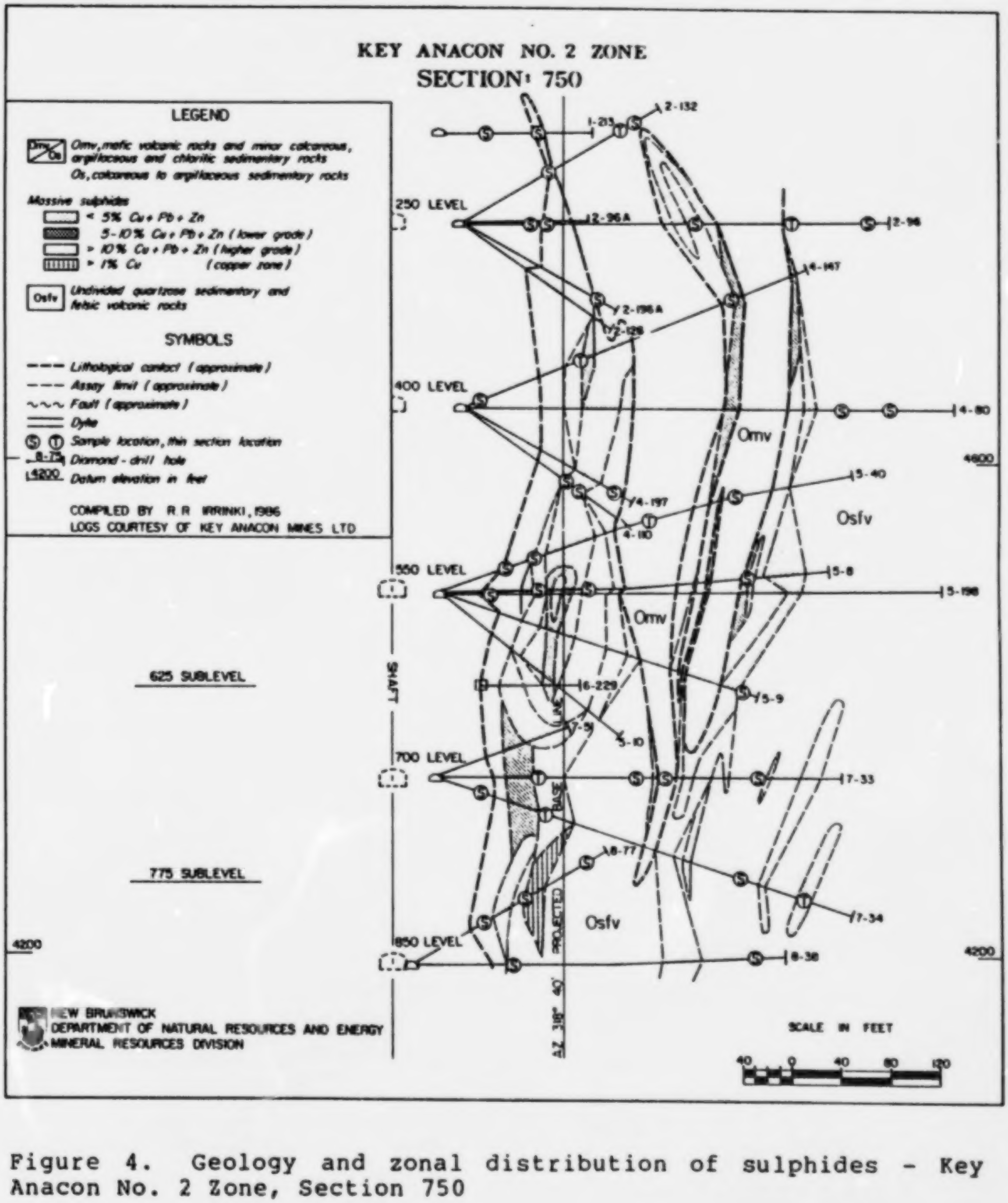

KEY ANACON NO. 2 ZONE
SECTION: 750
LEGEND
Omv, mafic volcanic rocks and minor calcareous, argillaceous and chloritic sedimentary rocks
Os, calcareous to argillaceous sedimentary rocks
Massive sulphides
< 5% Cu + Pb + Zn
5-10% Cu + Pb + Zn (lower grade)
> 10% Cu + Pb + Zn (higher grade)
> 1% Cu (copper zone)
Osfv Undivided quartzose sedimentary and felsic volcanic rocks
SYMBOLS
Lithological contact (approximate)
Assay limit (approximate)
Fault (approximate)
Dyke
Sample location, thin section location
8-75 Diamond-drill hole
4200 Datum elevation in feet
COMPILED BY R.R. IRRINKI, 1986
LOGS COURTESY OF KEY ANACON MINES LTD
250 LEVEL
400 LEVEL
550 LEVEL
625 SUBLEVEL
700 LEVEL
775 SUBLEVEL
850 LEVEL
SHAFT
PROJECTED CENTRE LINE BASE
AZ 318° 40'
1-213
2-132
2-96A
2-96
4-147
2-136A
2-126
4-80
4600
5-40
4-197
4-110
5-8
5-198
6-229
5-9
5-10
7-51
7-33
8-77
7-34
8-38
4200
Omv
Osfv
NEW BRUNSWICK
DEPARTMENT OF NATURAL RESOURCES AND ENERGY
MINERAL RESOURCES DIVISION
SCALE IN FEET
40
0
40
80
120

Figure 4. Geology and zonal distribution of sulphides - Key Anacon No. 2 Zone, Section 750

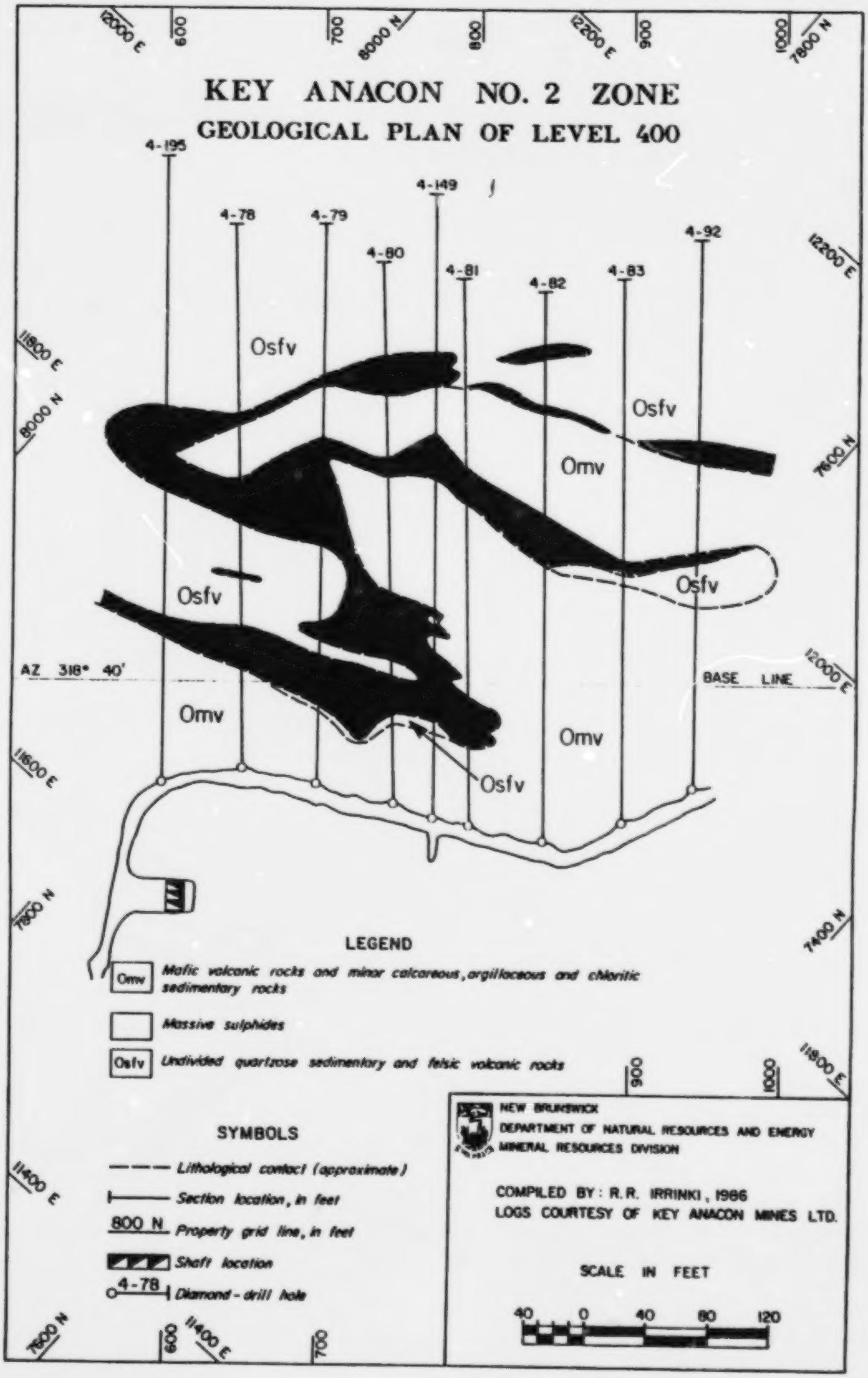

KEY ANACON NO. 2 ZONE
GEOLOGICAL PLAN OF LEVEL 400
12000 E
600
700
8000 N
800
12200 E
900
1000
7800 N
4-195
4-149
4-78
4-79
4-80
4-81
4-82
4-83
4-92
11800 E
8000 N
12200 E
7600 N
Osfv
Omv
AZ 318° 40'
BASE LINE
12000 E
11600 E
7800 N
7400 N
LEGEND
Omv Mafic volcanic rocks and minor calcareous, argillaceous and chloritic sedimentary rocks
Massive sulphides
Osfv Undivided quartzose sedimentary and felsic volcanic rocks
11800 E
SYMBOLS
Lithological contact (approximate)
Section location, in feet
800 N Property grid line, in feet
Shaft location
4-78 Diamond-drill hole
11400 E
7600 N
11400 E
NEW BRUNSWICK
DEPARTMENT OF NATURAL RESOURCES AND ENERGY
MINERAL RESOURCES DIVISION
COMPILED BY: R.R. IRRINKI, 1986
LOGS COURTESY OF KEY ANACON MINES LTD.
SCALE IN FEET
40
0
40
80
120

Figure 5. Key Anacon No. 2 Zone - Geological plan of Level 400

Table 1

Overall summary of Key Anacon No. 2 Zone in situ reserves

Grade Type	Approximate Average Thickness (ft.)	Proven Reserves (tons) T.F. 8	Grade				Expected Dilution (per cent)	Expected Dilution Grade (per cent of original grade)	Additional Probable Reserves (tons)
			Cu%	Pb%	Zn%	Ag oz./ton			
High	28	1 216 646	0.22	3.47	8.41	3.25	15	10	36 245
Low	15	314 210	0.16	1.50	4.75	1.04	-	-	30 726
Copper	10	76 908	1.45	0.41	1.08	0.77	-	-	18 882

The Road Copper Zone, lying 2000 feet (610 m) northwest of the Zone 2 shaft, was outlined by nine diamond-drill holes. One of the holes intersected 10.53% copper and 0.4 oz./ton (13.7 g/t) gold across 1.4 feet (0.4 m). The mineralization is mainly disseminated chalcopyrite in a zone 200 feet (60 m) long, 10 feet (3.1 m) thick, and extends to a depth of 500 feet (150 m).

A DETAILED STRUCTURAL STUDY OF THE HEATH STEELE Zn - Pb - Cu - Ag DEPOSIT NORTHUMBERLAND COUNTY

J.G. Torrance, Project Coordinator

This study is part of the Federal - Provincial MDA in which geological field investigations are to be carried out in the vicinity of the Heath Steele Mines Limited Property, N.B. Mining Lease #238 (Figure 6). The study is to be expedited as three linked phases starting on April 1st 1986 and spanning a period of three years. The long term objective of this project is to increase the known reserves of sulphide ore through detailed structural, geological, and geophysical investigation.

OBJECTIVES

The principal items for investigation during the span of this study include:

1) Compilation of all geological and geophysical data available at Heath Steele Mines, and assessment of its value as an aid in the determination of the spatial distributions of lithologic units.

2) Establishment of the structural and stratigraphic relationships between the following ore zones (Figure 7):
   (a) the "B5" and "B" zones
   (b) the "B" zone and the "E" zone
   (c) the "E" zone and the "ACD" zones
   (d) within the "ACD" zones
   (e) the western extension of these zones

3) Trenching of areas outlined by (1), above, and critical to the successful completion of (2).

4) Digitization of relevant data collected and compiled in any of the above categories, utilizing both microcomputer and mainframe systems.

5) Study of the relationship between metamorphism and structure of the mine rock units.

Studies in categories 1, 2a, 2b, 3, and 4 have been launched as part of the Phase I project initiative.

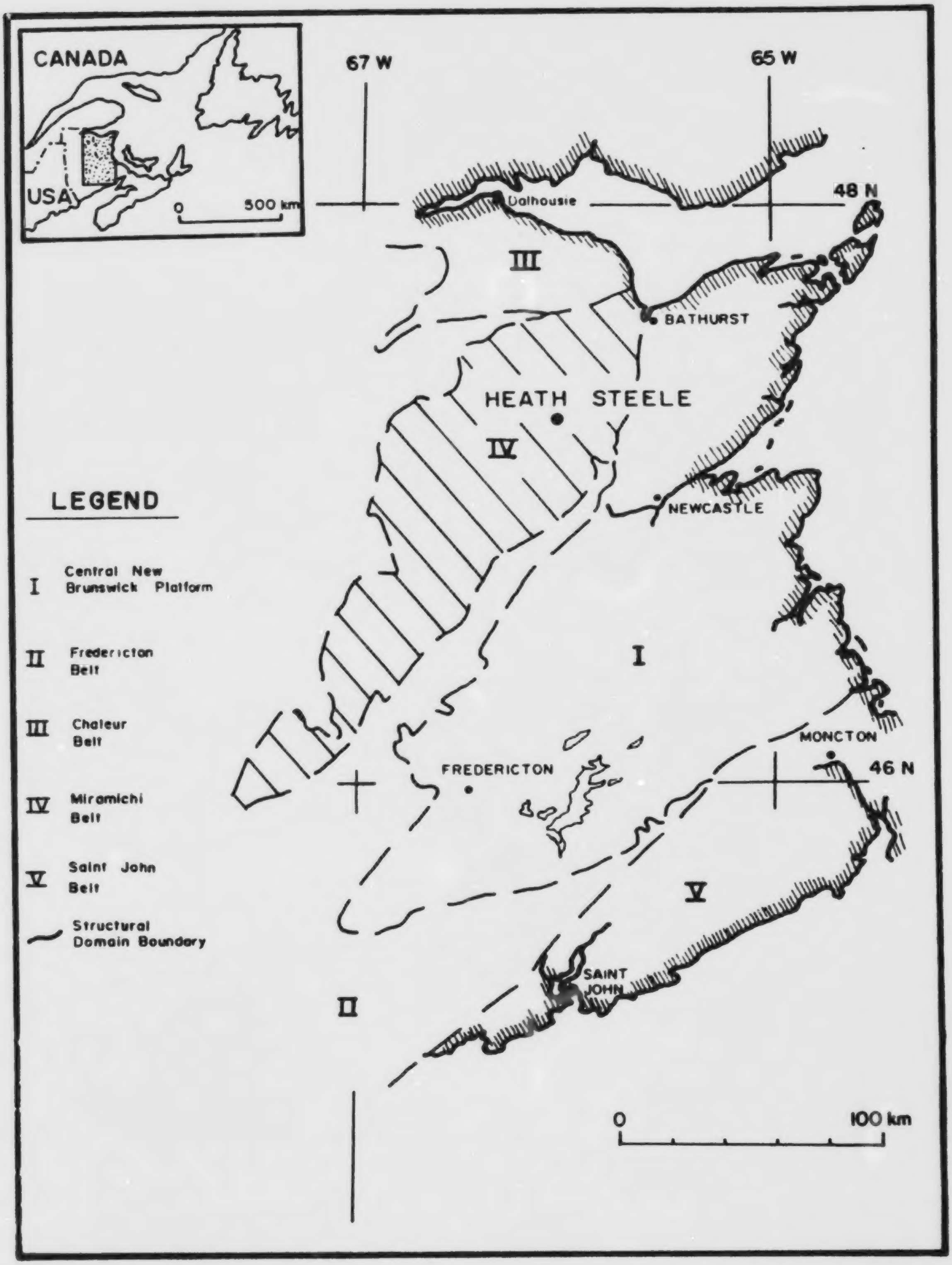


Figure 6. Location of Heath Steele Mines in north-central New Brunswick

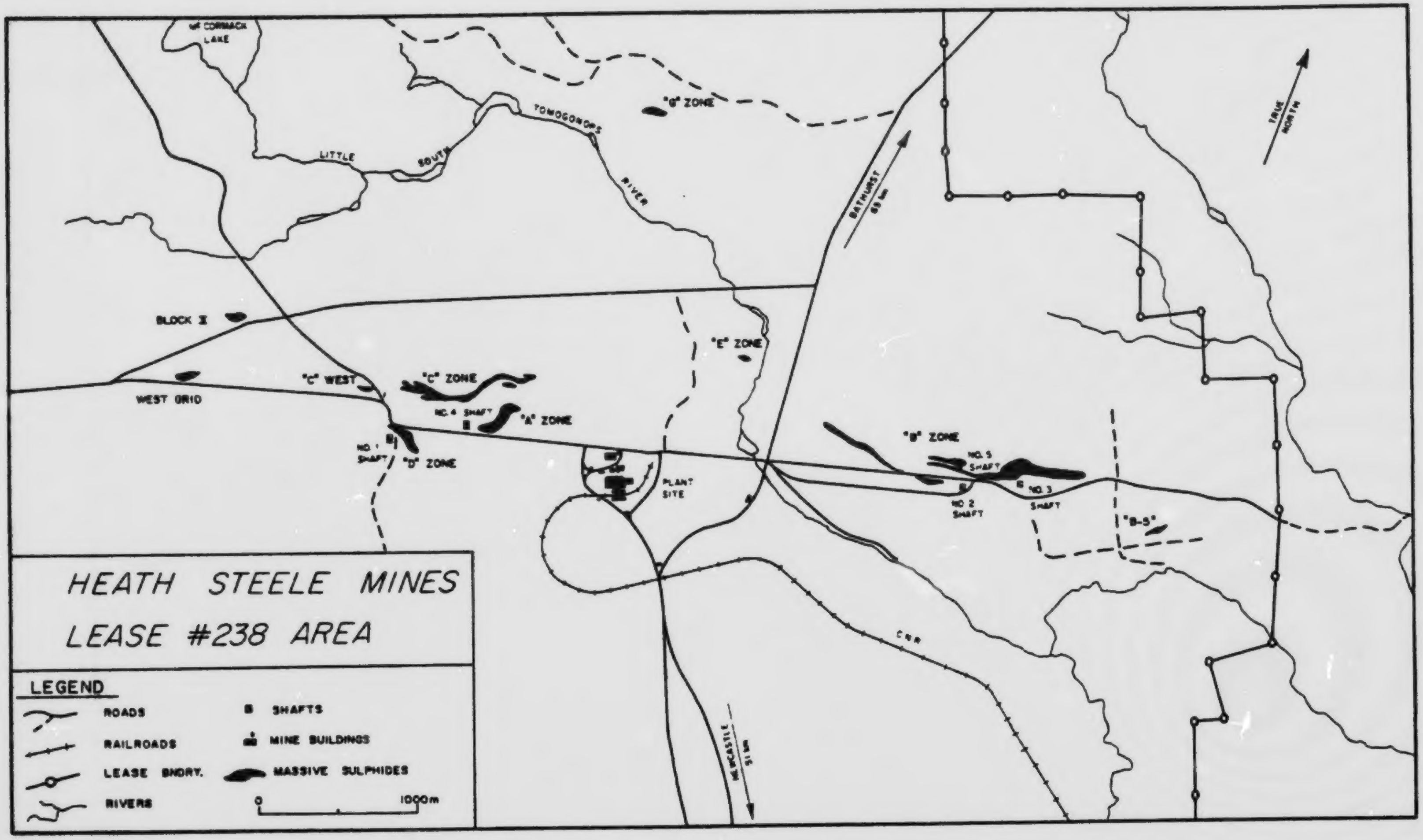


Figure 7. Ore zone location map within the mine lease area

CURRENT WORK

To date, the majority of the acquired surface and airborne geophysical data (magnetic, VLF, IP, and Max-Min) has been processed and plotted on common scale compilation overlays of the Lease 238 area. Geological data has also been compiled along with surface drill-hole plans.

All available drill-hole data (both surface and underground) has been digitized using an IBM-XT microcomputer in preparation for construction of composite cross sections and elevation plans of each ore body. Such sections are integral to the 3-D analysis of structural style and associated deformational mechanisms of the ore zones.

Field work this season saw the completion of structural mapping of the "B-zone" underground workings by Mr. C. Moreton (graduate student at UNB) in addition to surficial mapping in the "B", "B5", and "E" zone environs. Mr. G. Allcott (graduate student at UNB) conducted detailed magnetic and VLF surveys over selected portions of both the "B5" and "E" zones in an attempt to follow lithologic contacts along strike where surface exposure is minimal.

Extensive surface trenching was conducted in these areas because of a paucity of rock exposure and diamond-drill-hole data. A total of 1800 m of trenches (some 90% of the total Phase I trenching) has been completed to date, with approximately 400 m of rock being newly exposed. The lithologic and detailed structural mapping of the trenches is currently being completed. The trenches afford the opportunity of defining the macroscopic and mesoscopic nature and geometries of structural elements within the mine sequence rock units.

PROPOSED WORK

It is anticipated that the completion of Phase I work will include: (a) further digitization of geologic and geophysical data as well as computer generation and manipulation of composite sections and plans; (b) field mapping of the western portion of the Lease 238 area (west of the "ACD" zones); and (c) the enhancement of Landsat images of the mine and surrounding region in an attempt to outline prominent lineaments (faults?) that may have a bearing on the tectonic evolution of this part of the Bathurst Mining Camp.

PUBLICATIONS 1986 - BATHURST REGIONAL OFFICE

DAVIES, J.L. 1986. Arsenic, antimony, barium and gold content of stream sediments, map J-6, Northwest Upsalquitch, Twenty-eight Mile to Chisholm Brooks (21 O/11E). Scale: 1:25 000. New Brunswick Department of Natural Resources, Mineral Resources Division, Map Plate 81-47j.

_________ 1986. Arsenic, antimony, barium and gold content of stream sediments, map K-6, Nine Mile and Oxford Brooks (21 O/10W). Scale: 1:25 000. New Brunswick Department of Natural Resources, Mineral Resources Division, Map Plate 81-49j.

_________ 1986. Arsenic, antimony, barium and gold content of stream & spring sediments, Serpentine Lake (21 O/2). Scale: 1:50 000. New Brunswick Department of Natural Resources, Mineral Resources Division, Map Plate 83-33m.

_________ 1986. Arsenic, antimony, barium and gold content of stream sediments, map J-5, parts of Burntland, Richie and Indian Brooks (21 O/11E). Scale: 1:25 000. New Brunswick Department of Natural Resources, Mineral Resources Division, Map Plate 83-61j.

_________ 1986. Arsenic, antimony, barium and gold content of stream sediments, map L-6, head of McCormack, Ferguson, and Ramsey Brooks (21 O/10). Scale: 1:25 000. New Brunswick Department of Natural Resources, Mineral Resources Division, Map Plate 83-62j.

_________ 1986. Arsenic, antimony, barium and gold content of stream sediments, map M-5, forks of Southeast and Little Southeast Upsalquitch Rivers (west half only) (21 O/10E). Scale: 1:25 000. New Brunswick Department of Natural Resources, Mineral Resources Division, Map Plate 83-63j.

_________ 1986. Arsenic, antimony, barium and gold content of stream sediments, map M-6, junction of Ramsay and Murray Brooks (west half only) (21 O/10E). Scale: 1:25 000. New Brunswick Department of Natural Resources, Mineral Resources Division, Map Plate 83-64j.

_________ 1986. Arsenic, antimony, barium and gold content of stream sediments, Sisson (21 O/6g). Scale: 1:20 000. New Brunswick Department of Natural Resources, Mineral Resources Division, Map Plate 84-18g.

_________ 1986. Arsenic, antimony, barium and gold content of stream sediments, Sisson (21 O/6h). Scale: 1:20 000. New Brunswick Department of Natural Resources, Mineral Resources Division, Map Plate 84-19g.

SUSSEX REGIONAL OFFICE

ACTIVITIES OF THE SUSSEX REGIONAL OFFICE

A.A. Ruitenberg, Regional Geologist

The Sussex Regional Office consists of A.A. Ruitenberg, Regional Geologist; S.R. McCutcheon, Assistant Regional Geologist; M.R. Mazerolle, Engineering Technician and Mrs. F.H. Kelly, Administrative Services Officer. M.J. McLeod, S.E. Watters, and S.C. Gouthro were employed on projects under the Federal-Provincial MDA. D.G. Rose was contracted under the MDA in the fall.

The two projects initiated in 1985 under the MDA agreement with the Government of Canada, were continued in 1986. The detailed geological and geochemical investigation of tin-tungsten-bearing rocks was extended to cover the entire eastern Saint George Batholith. The detailed stratigraphic, structural and mineralogical study of the gold-bearing rocks along the Bay of Fundy coast was extended eastward into the West Bay area and westward into the Musquash Harbour area.

Other projects that were continued or started during the season include: a) the detailed stratigraphy, petrology, and petrochemistry of the rocks in the Mount Pleasant caldera, b) mapping and sampling of tills covering the copper- and gold-bearing rocks in the Mascarene Peninsula and the West Isles in the Bay of Fundy c) compilation of mineral-deposit data, preparation of a metallogenic map of New Brunswick and a simplified, smaller scale version for inclusion in a metallogenic map of the Appalachians and d) comparative investigation of gold deposits conducted in co-operation with company and other departmental geologists e) consulting services provided for exploration companies, prospectors, and other government departments f) a program to computerize mineral deposits data in the province was started in the fall.

SAINT GEORGE BATHOLITH TIN-TUNGSTEN PROJECT

M.J. McLeod, Project Geologist

Geological mapping, geochemical sampling, and economic evaluation of the eastern Saint George Batholith was continued with the assistance of B. Mitton. The geological mapping in the Victoria Lake area has been finalized but that in the Mount Douglas area is preliminary (Figure 8).

Two essential divisions, the Victoria Lake and Mount Douglas suites, have been tentatively outlined that may reflect deeper and shallower erosional levels, respectively, through probable comagmatic intrusions. The Mount Douglas suite may be slightly younger than the Victoria Lake suite and a boundary between the two is shown on Figure 8. These are both considered distinct from and younger than the Utopia and Magaguadavic granites to the west. Ar 40/39 dates yield a Late Devonian age for the Victoria Lake suite.

The eastern Saint George Batholith is comprised of a series of coarse-grained seriate and fine-grained porphyritic phases with apparently little temporal discordance. The earliest phase is unique to the Mount Douglas suite and is represented by grey to pink coarse-grained to very coarse grained biotite-rich granite (Unit 1a) that is transitional to grey porphyritic biotite-rich microgranite (Unit 1b). Both units commonly display rapakivi textures and contain abundant country rock xenoliths. These units occur as mappable units near the southern and eastern boundary of the suite but also as isolated outcrops along the northwestern contact.

The next phase occurs as buff to red, very coarse grained seriate, rapakivi biotite granite (Unit 2a) transitional to dark red porphyritic microgranite (Unit 2b). This porphyritic phase, that is distinguished by its colour and by a very fine grained and occasionally glassy matrix, occurs as a mappable unit near the northwest boundary of the suite. Unit 2a occurs throughout the Mount Douglas suite as irregular bodies with poorly defined contacts. A porphyritic and aplitic unit (virtually identicle to Unit 2b) and rocks similar to Unit 2a, occur along the western boundary of the Victoria Lake suite. Age relationships of these rocks, however, are uncertain.

The most widely distributed phase in both the Victoria Lake and Mount Douglas suites is a buff to pink, medium- to coarse-grained, seriate, biotite granite usually with some rapakivi textures (Unit 3). In the Victoria Lake area, this unit appears fairly uniform with only minor textural variation. In the Mount Douglas area, however, small country rock xenoliths occur sporadically and numerous internal contacts are present indicative of multiple intrusions.

Unit 3 in the Victoria Lake area is intruded by a central elongated unit of grey, medium- to fine-grained, equigranular biotite granite with relatively low silica content (Unit 4a). A variably textured marginal phase that consists of red, medium- to fine-grained equigranular biotite granite (Unit 4b) and red to buff porphyritic biotite microgranite and aplite (Unit 4c) is developed around and above Unit 4a. These marginal units commonly dip shallowly beneath Unit 4 and are exposed as cupolas at several localities with or without pegmatitic cups.

Unit 4 in the Mount Douglas area is manifested by domes and irregularly shaped bodies of Unit 4c. Where the upper contacts of domes are exposed, Unit 4c can grade into phenocryst-packed porphyries or fine- to medium-grained and commonly porphyritic biotite granite (Unit 4d) that can be either seriate or equigranular. Unit 4d is, therefore, commonly confused with older finer grained seriate or equigranular units. Contacts of Unit 4 with Unit 3 are generally sharp near the boundary of the suite but appear to be locally gradational toward the interior. Units 4 and 4d occur throughout the Mount Douglas suite and are particularly well exposed along the northwest contact.

Features such as miarolitic cavities, pegmatites, and granophyric textures, that are indicative of high levels of emplacement are abundant throughout the eastern Saint George Batholith but are most common in the Mount Douglas suite. Also, the presence of multiple intrusions of similar phases, the presence of country rock xenoliths, and the occurrence of probable contaminated granites (Unit 1) in the Mount Douglas suite attests to the proximity of these granites to thin roof zone relative to the granites in the Victoria Lake suite.

Tin- and tungsten-bearing greisen and alteration zones occur almost exclusively within or around Unit 4 in the Victoria Lake area. Units 4b and 4c are chemically highly differentiated, at least in the Victoria Lake suite. The relatively unaltered nature of Unit 4a relative to all of the units in the area and the presence of greisens within this unit supports the interpretation that Unit 4, and in particular Unit 4a, is the source of the mineralizing fluids. Consequently, the mineralization is probably in part endogranitic. This association is less obvious in the Mount Douglas area where erosion has not exposed underlying source granites. Medium- to fine-grained equigranular granites of Unit 4a are inferred at depth beneath the central belt of mineralization in this area.

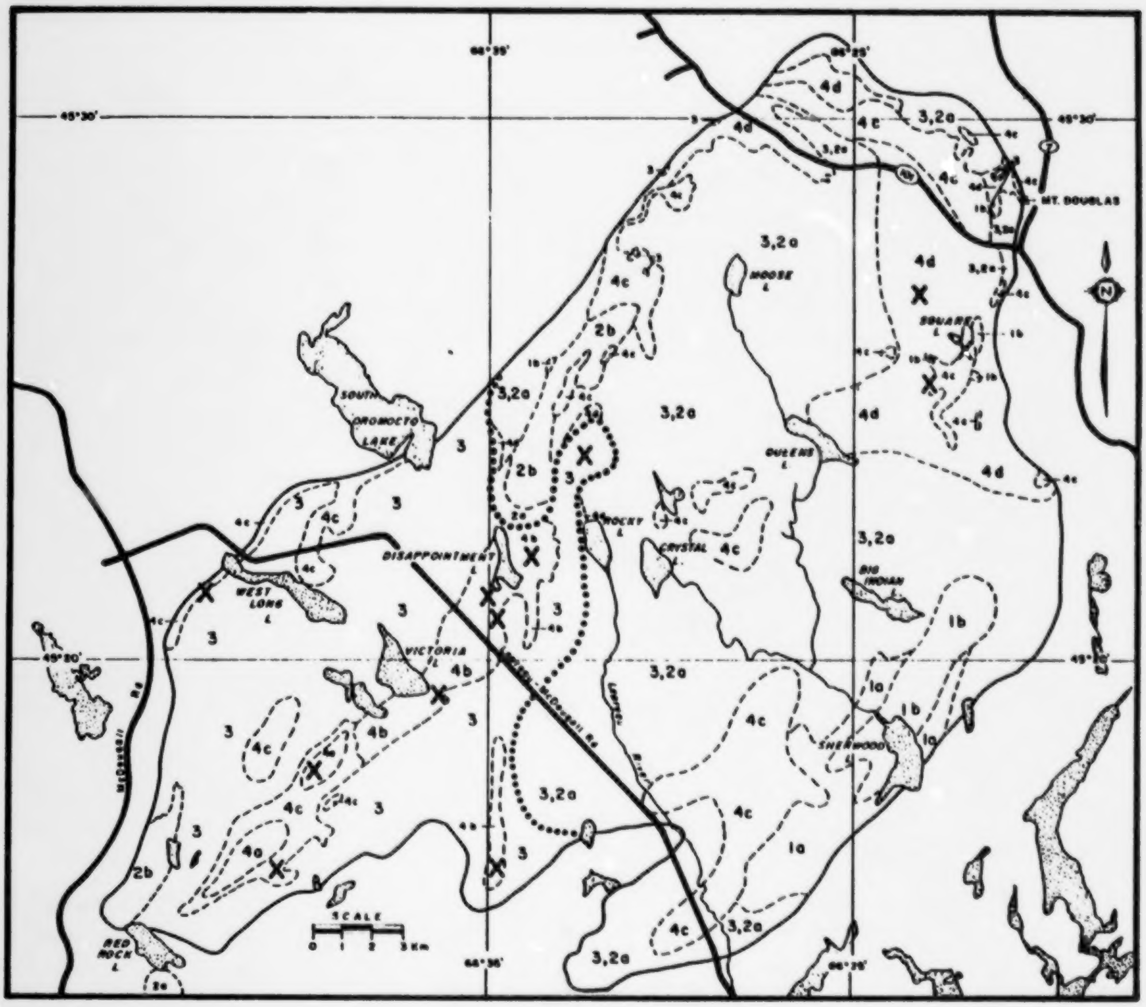


Figure 8. Geology of eastern Saint George Batholith

Investigation of the tin and tungsten potential of the batholith is continuing within the geological framework presented. Thorough assessment of these areas is ongoing via geochemical sampling and detailed petrographic studies in an effort to extend known mineralized zones and to delineate new exploration targets. Particular attention is presently being focused on the gold potential in the contact zone of the batholith.

LEGEND

UPPER DEVONIAN

4d	Fine- to medium-grained, equigranular or slightly seriate biotite granite; commonly contains quartz phenocrysts
4c	Porphyritic biotite microgranite and aplite
4b	Red, medium- to fine-grained equigranular biotite granite
4a	Grey, medium- to fine-grained equigranular biotite granite
3	Medium- to coarse-grained seriate biotite granite; variable but usually minor rapakivi texture
2b	Porphyritic biotite microgranite with well-developed rapakivi texture; the matrix is commonly cryptocrystalline
2a	Very coarse grained, seriate, rapakivi biotite granite
1b	Porphyritic biotite-rich microgranite; rapakivi textures commonly well developed
1a	Coarse-grained to very coarse grained seriate biotite-rich granite

SYMBOLS

————	Road
-------	Geological contact
....	Tentative boundary between Victoria Lake and Mount Douglas suites
X	Major occurrences of tin- and/or tungsten-bearing greisen or alteration zones

INVESTIGATION OF GOLD-BEARING ROCKS - BAY OF FUNDY COASTAL ZONE

S.E. Watters, Project Geologist

An investigation of the gold-bearing rocks along the Fundy coastal zone was continued, concentrating this year on major structures and stratigraphic relations to the north and northeast of Cape Spencer. This work is in progress at the time of writing. Figure 9 shows the coastal extent of formations described in the 1985 report along with locations where altered sediments were sampled for chemical analysis. The sequence of Carboniferous or older age is here referred to informally as the Cape Spencer redbeds.

Several type sections were visited this year in an attempt to establish the age of the Cape Spencer redbeds but no correlations were obvious. Samples of limestones from this formation have not yielded any microfossils. Carbon isotope analysis of the limestones is being considered as a method of narrowing down the possible age range.

Field work this year indicates that the coastal exposure at Cape Spencer point is an altered arkose probably resting unconformably on the granite body exposed near the lighthouse similar to that described to the northeast. A similar arkose unit hosting a gold occurrence is found northeast of Cape Spencer at West Beach. These units appear to grade into the finer purple sediments of the Cape Spencer redbeds (Figure 10).

Structural work has delineated the surface trace of the nose of a major northwest-closing D_2 fold (Figure 9). Its regional significance is not yet determined. A major pre- or early syn-D_2 tectonic breccia is presently being outlined in the Cape Spencer - Millican Lake area. Fragments of this breccia are strongly deformed by D_2 folding.

Two hundred rock samples collected during the 1985 field season were analysed for the eight elements Au, Ag, Cu, Pb, Zn, As, Sb, and Ba. Altered samples from 16 alteration zones were analysed in addition to unaltered samples of the various lithologies in each formation to establish background values. Most gold values in unaltered samples of all formations were found to be below the 1 ppb detection limit.

The Balls Lake Formation is particularly low in gold content with only two of the thirty-three samples analysed having gold in amounts greater than 1 ppb. Grey spotted slates were the only unaltered lithology of the Lancaster Formation found to contain gold above the detection limit. Gold found in the Precambrian granite at Cape Spencer was below detection but a pegmatite vein within it contained 2 ppb. Unaltered lithologies of the Cape Spencer redbeds were likewise commonly below the 1 ppb gold detection limit but a few unaltered conglomerate, sandstone, siltstone, and slate samples contained between 1 and 4 ppb gold. One purple spotted slate at Thomas Peninsula had 27 ppb gold and one limestone near Ploughshare Rock had 22 ppb gold.

Altered samples with pyrite from the Balls Lake Formation were below detection for gold. Values obtained from samples of fine-grained sediments in an alteration zone in the Lancaster Formation (Figure 10) varied from below detection to 15 ppb gold. The highest gold values were obtained from altered sediments and veins in the Cape Spencer redbeds. These varied widely, however, from below detection to 40 ppm. A rhyolite dyke cutting Cape Spencer arkose yielded 2400 ppb gold. Massive quartz veins in thrusts between the Cape Spencer redbeds and Lancaster Formation (Figure 10) contained up to 61 ppb gold.

Of the other elements analysed, Ag follows most closely the pattern of the gold concentration. All other elements, particularly Cu and Pb, commonly occur in anomalously high levels in samples that are high in gold content. The highest Zn, Ba, and Pb values, however, are found in rocks not anomalous in gold. The highest As and Sb values tend to occur in large quartz veins having low gold values.

Several three kilogram samples of Cape Spencer-type gold ores were taken to determine the relative concentration of gold in the heavy, pyrite-rich fraction of the 1/2" crushed ore. The heavy fraction was concentrated by panning the less-than-1/4" portion which constituted 60% of the original ore sample. Gold was found to be strongly enriched in the pan concentrates, the average (29 g/t Au) being 17 times that in the remainder of the sample (1.7 g/t) or 13 times the concentration in the original ore sample (2.2 g/t). The heavy fraction constituted only 2 weight % of the original ore sample and contained one-quarter of the total gold in the sample.

Significant amounts of pyrite were present as poly-minerallic grains both in the light rejects from panning and in the unpanned less-than-1/4" portion of the sample. Similar tests on finer crushed ore could test the feasibility of onsite preconcentration of Cape Spencer-type gold ores.

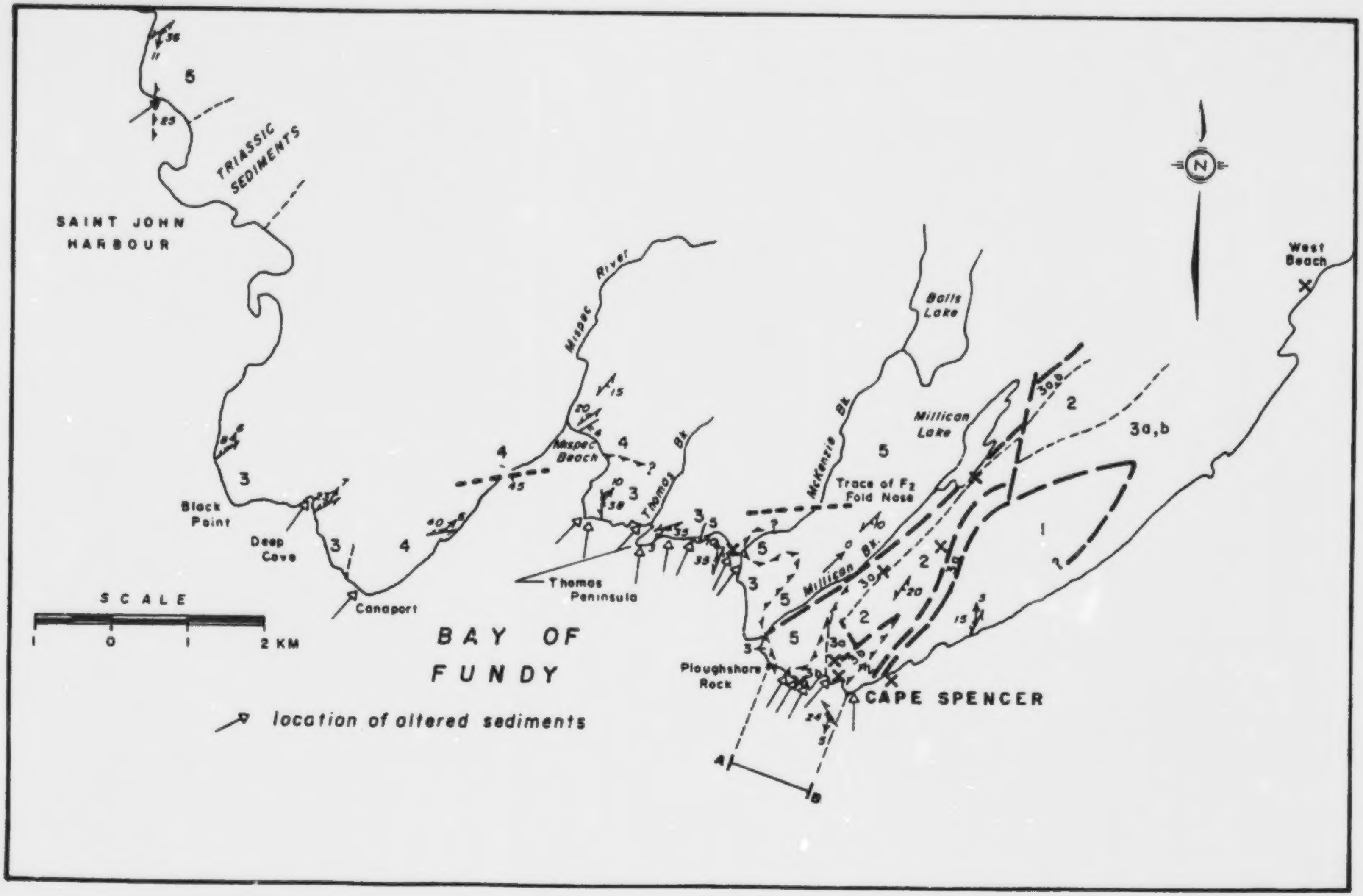


Figure 9. Coastal geology - Cape Spencer to Saint John Harbour

LEGEND

CARBONIFEROUS

LANCASTER FM

5	Grey quartzose siltstone, sandstone, and conglomerate

BALLS LAKE FM

4	Red sandstone, slate, and quartz-pebble conglomerate

CARBONIFEROUS OR OLDER

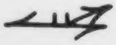
CAPE SPENCER REDBEDS

3	3a Greyish purple arkosic sandstone and conglomerate; 3b Greyish purple sandstone, siltstone, and conglomerate

PRECAMBRIAN and/or YOUNGER

2	Granodiorite and granite
1	Grey and greenish grey siltstone, sandstone, conglomerate, and basalt

SYMBOLS

- - - - - - - -	geological contact
— — —	fault
▲ ▲ ▲ ▲	thrust fault
┴ ┴┴	bedding; upright, tops unknown
	cleavage; S_1, S_2
	D_2 stage fold with associated axial surface cleavage
✕	gold occurrence
A├────┤B	location of cross section

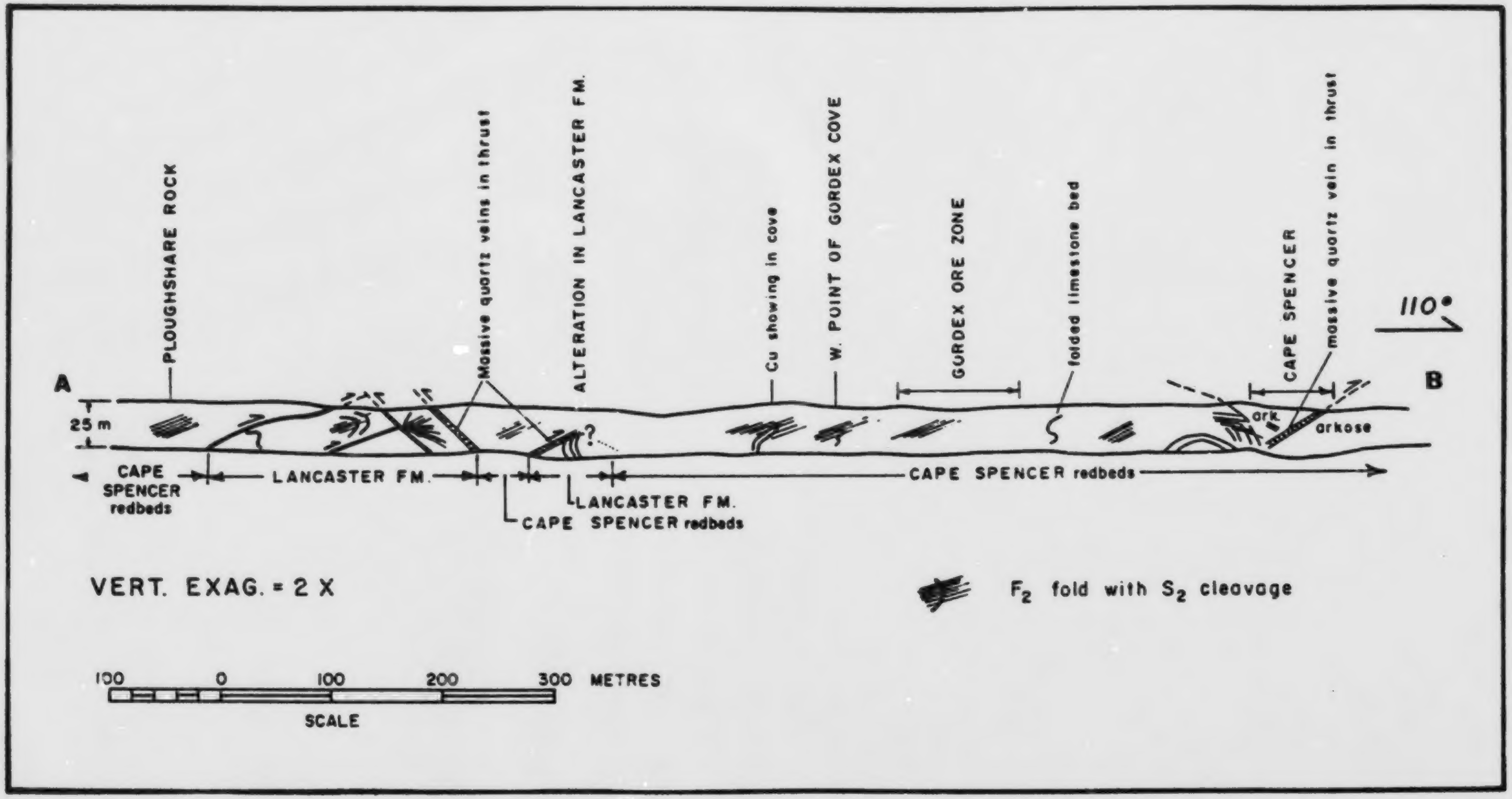


Figure 10. Schematic cross section from Ploughshare Rock to Cape Spencer showing major D_2 thrusts and folds

METALLOGENIC INVESTIGATIONS

S.C. Gouthro, Project Geologist

Compilation of mineral occurrence and metallogenic map data that was started in 1984 by D. Hattie and A.A. Ruitenberg, was continued this year. Basic information such as location, major and minor commodities, geology, structure, assessment work, etc., was entered onto data sheets which will be kept in the mineral deposits file.

A 1:1 000 000 scale metallogenic map of the province was produced using a geographic base and constructing three overlays on which 1) geologic age and structures 2) generalized stratigraphy and intrusive rocks 3) metallogenic data, were plotted. This map will be part of the Appalachian Metallogenic Map that is currently being compiled by the U.S. Geological Survey.

A.A. Ruitenberg continued a comparative study of gold deposits in the Province in cooperation with company and other departmental geologists. Preliminary results of this investigation were presented at the Prospectors and Developers Annual Meeting in Toronto and a gold deposit symposium held at the Annual Meeting of the Northeastern Section of the Geological Society of America in Kiamesha Lake, New York. Consulting services on gold potential in various areas were provided for numerous company geologists and prospectors.

S.E. Watters and A.A. Ruitenberg also attended the International Gold '86 Symposium in Toronto. In addition to numerous well-illustrated papers, drill cores from more than 25 gold deposits were on display at the meeting.

MINERAL DEPOSITS COMPUTER FILE

D.G. Rose, Project Geologist

In September 1986, D.G. Rose and S.C. Gouthro began a project that will build a computerized file of selected data on documented mineral occurrences in New Brunswick.

The file will be assembled at the Sussex office using a micro (desk top) computer system. It will draw upon existing (non-automated) inventories and compilations and incorporate recent (non-confidential) data from assessment reports.

The principal applications of this file would include:

a) Plots and tabular listings for reconnaissance studies by individuals or companies not familiar with a particular area.

b) Support for resource assessments or mineral potential studies.

c) Support for commodity studies, e.g. commodities vis-a-vis age of host or associated rocks, etc.

d) Provide quick access to references on a specific occurrence, region, or commodity.

e) Provide speed and flexibility in plotting.

f) Serve as a foundation or skeleton for building more detailed or customized files.

The preliminary file design provides for the following categories of data:

1. Identification

2. Location

3. Commodities and development status

4. Minerals

5. Deposit types: New Brunswick classification and "Geological Survey of Canada classification"

6. Deposit description

7. Tectonostratigraphic Zone/Belt

8. Rock type - host and associated rocks
9. Stratigraphic unit
10. Age - Stratigraphic and radiometric for host rocks, associated rocks and mineralization
11. Relationship of mineralization to host rock, structure, and metamorphism
12. Geophysical response
13. Reserves, production and/or assay data
14. Cross-references to other files
15. Map references
16. Bibliography

MOUNT PLEASANT CALDERA PROJECT

S.R. McCutcheon, Assistant Regional Geologist

Laboratory investigations were continued and a detailed report was begun on the stratigraphy, petrography, and petrochemistry of the rocks comprising the Mount Pleasant caldera. Many of the preliminary conclusions from field mapping have been substantiated by laboratory studies conducted during the past winter but others have been modified and/or completely changed.

One of the most surprising discoveries was a diverse and well-preserved miospore assemblage in the upper part of the Carrow Formation which indicated that most, if not all, of the Piskahegan Group is Late Devonian (Famennian) rather than Carboniferous. On the geologic time scale of Haarland *et al*., (1982), the absolute age of the Famennian is 360-367 Ma, an age that is significantly older than whole rock isotopic dates on the Mount Pleasant deposit, reported by Kooiman *et al*., (in press).

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TILL GEOCHEMISTRY AND MAPPING PROJECT

P.G. Chiswell, Project Geologist

The tills covering the gold-bearing and base-metal-sulphide-bearing rocks in the Mascarene Peninsula and West Isles in the Bay of Fundy were mapped and sampled with the assistance of L. Long (Figure 11). The area includes 1:20 000 map sheets 21 G/2c, 21 G/2d, and 21 B/15e. Sampling was done on a 1 km grid spacing. At each locality a pit was dug, the soil profile was described, and samples were taken from the humus B- and C-horizons with an additional sample of approximately 30 - 40 lbs. being taken from the C-horizon for heavy-mineral analysis.

The map area is relatively low-lying with moderate relief. Hills are mostly outcrop with extensive glacial till in between. Sand and gravel deposits occur in the northern part of the map area.

Four surficial map units have been distinguished in the area. The lowermost unit is a bedrock-basal till complex comprising a thin veneer up to 1 m thick on bedrock. The basal till is mainly composed of locally derived Silurian mafic and felsic volcanic and sedimentary rock fragments in a sandy clay matrix.

The basal till unit is overlain by a reworked ablation till complex composed of poorly sorted gravel with boulders up to 1 m across. The till is composed of Early Devonian to Early Carboniferous granite and gabbro, Silurian mafic and felsic volcanic and sedimentary rocks, and Carboniferous clastic sedimentary rocks. The till ranges in thickness from a thin veneer to about 30 m.

The outwash deposits in the northern part of the map area are composed of well-sorted, quartz-rich sands and gravels. The gravels are composed of Early Devonian - Early Carboniferous granite, Silurian - Early Devonian granite, black slate, mafic and felsic volcanic rocks. The deposit exhibits excellent grading, cross-bedding, sand dykes, flume structures, and faults. The sandy beds are up to 11 m thick whereas the gravel beds are generally only up to 1 m thick.

The uppermost unit is composed of massive, dense clay and silt that varies in colour from grey to dark brown. Near the contact with the outwash, the unit is composed of sandy clay.

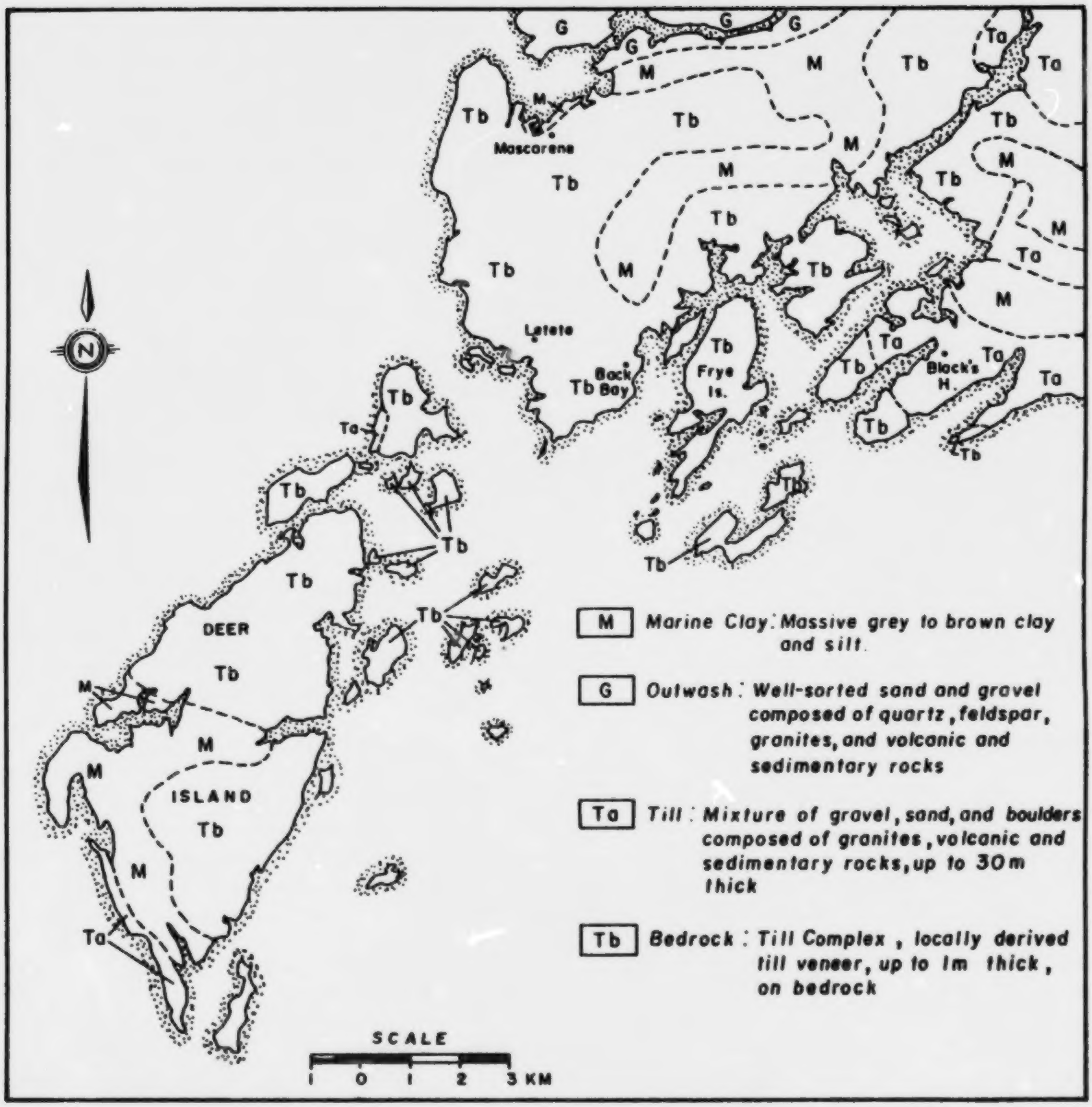
G
G
G
G
M
Ta
Tb
Mascarene
Letete
Back Bay
Frye Is.
Block's H.
DEER
ISLAND
N
M Marine Clay: Massive grey to brown clay and silt.
G Outwash: Well-sorted sand and gravel composed of quartz, feldspar, granites, and volcanic and sedimentary rocks
Ta Till: Mixture of gravel, sand, and boulders composed of granites, volcanic and sedimentary rocks, up to 30m thick
Tb Bedrock: Till Complex, locally derived till veneer, up to 1m thick, on bedrock
SCALE
1 0 1 2 3 KM

Figure 11. Surficial geology of the Mascarene - West Isles area

PUBLICATIONS 1986 - SUSSEX REGIONAL OFFICE

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GEOSCIENTIFIC SERVICES - SOILS & MINERALS BLDG.

ACTIVITIES OF THE GEOSCIENTIFIC SERVICES SECTION

L.R. Fyffe, Staff Geologist

The Geoscientific Services staff at the Soils and Minerals Building in Fredericton consists of L.R. Fyffe (staff geologist), R.R. Irrinki (Metallic Minerals Geologist), G.W. Crouse (Core Librarian), V. Rinco (Geochemical Analyst), and B. Edney (Laboratory Assistant).

In addition to the regular staff activities, several projects were carried out by contract and summer personnel under the MDA. In central New Brunswick, H.E. MacLellan undertook petrochemical and radiometric studies of the Burnthill Granite, and W.W. Gardiner and K. Garnett mapped the tin-bearing Dungarvon Granite; A.G. Pronk mapped the surficial geology of the Upsalquitch Forks area in northern New Brunswick; and R. Wilson (working out of the Bathurst Office), mapped the volcanic rocks of the New Denmark area of west-central New Brunswick.

STRATIGRAPHIC NOMENCLATURE IN NEW BRUNSWICK

A 572-page book entitled "Lexicon of Canadian Stratigraphy, Volume VI, Atlantic Region", edited by G.L. Williams, L.R. Fyffe, R.J. Wardle, S.P. Coleman-Saad, and R.C. Boehner, was published by the Canadian Society of Petroleum Geologists in late 1985. This volume contains a summary of all formal stratigraphic terms currently in use in the Atlantic Provinces and offshore areas. Informal and abandoned terms are also listed. The accompanying bibliography includes more than 2000 references.

The compilation of this lexicon began in 1982. Some 300 entries were written up for New Brunswick with L.R. Fyffe being responsible for the pre-Carboniferous, S.M. McCutcheon for the Carboniferous, and J.J. Thibault for the Quaternary. An example of one of these entries is given on the following page.

This lexicon volume was prepared in order to create a standardized nomenclature. There has been inconsistency in the past because of failure to adhere to the North American Stratigraphic Code. In addition, it should serve as a handy reference source for those who wish to become familiar with the geology of specific areas.

TETAGOUCHE GROUP **Cambrian-Late Ordovician**

Author: Young, 1911; redefined by Skinner and McAlary, 1952.

Type Locality: Tetagouche Falls, 12 km west of Bathurst, Gloucester County, New Brunswick (NTS 21 P/12W).

Lithology: Poole (1963) established the following unnamed formations within the Tetagouche Group at Lower Birch Island on the Southwest Miramichi River in York County, central New Brunswick (NTS 21 J/10E): (1) light grey to greenish-grey massive to laminated quartzite and slate overlain by a few metres of fossiliferous calcareous siltstone with intercalated felsic tuff (Neuman, 1968, 1984); (2) a thin unit of red and green ferromanganiferous slate and chert; (3) a thin unit of black graphitic slate and chert; and (4) light to dark grey greywacke and slate, minor grit and pebble conglomerate. A similar sequence has been recognized at Tetagouche Falls (Fyffe, 1976) and in the Upsalquitch Lake area (NTS 21 O/7), 60 km to the west of Bathurst (Helmstaedt, 1971), where thick units of rhyolite, quartz-feldspar porphyry (crystal tuff), and pillow basalt are intercalated with formations 2 and 3 and the lower part of formation 4. An iron formation, equivalent to formation 2, and massive sulphide deposits are associated with the felsic volcanic rocks (Young, 1911; Lea and Rancourt, 1958; Boyle and Davies, 1964). The Tetagouche Group of southwestern New Brunswick has been divided into an unnamed quartzite-slate unit, the overlying Pocomoonshine Volcanics, and uppermost Belle Lake Slate (Venugopal, 1978).

Thickness and Distribution: Skinner (1974) estimated a thickness of 10,000 m for the group in the Bathurst area. It extends from the Bathurst area southwestward for 250 km to the Woodstock area of Carleton County (NTS 21 J/4). It underlies an area of roughly 8000 km^2.

Relations to Other Units: In central New Brunswick, rocks of the Tetagouche Group grade into paragneiss, interpreted to be high grade metamorphic equivalents of the lower part of the group (Poole, 1963; Skinner, 1975; Fyffe, 1977), or Precambrian basement (Rast *et al.*, 1976). Upper Silurian conglomerate of the Chaleurs Group unconformably overlies basalt of the Tetagouche Group west of Bathurst (NTS 21 O/9, 10) (Helmstaedt, 1971; Skinner, 1974). Silurian conglomerate unconformably overlies quartzite and slate of the group near Canterbury, 30 km south of Woodstock (NTS 21 G/14) (Lutes, 1979). The Tetagouche is in fault contact with Silurian rocks in the southeast. Carboniferous conglomerate unconformably overlies the group in the east for 60 km south of Bathurst.

Age Justification: Brachiopods, from a thin unit of calcareous slate at the very top of the thick sequence of quartzite and slate (formation 1) forming the lower portion of the Tetagouche Group, are Early Ordovician (Neuman, 1968, 1984). This would suggest that the lower part may be as old as Cambrian. An erosional break separates the Lower Ordovician limey rocks from the underlying sequence on the Tetagouche River downstream from Tetagouche Falls (Fyffe, 1976). Graptolites collected by Forbes from a local black slate unit underlying the Pocomoonshine Volcanics on Eel River at Benton, 20 km south of Woodstock, are late Tremadoc (Fyffe *et al.*, 1983). Graptolites recollected by Bailey (1906a) in formation 3 near the mouth of the Tetagouche River (NTS 21 P/12) are Caradoc (Ami, 1906) as are trilobites from limestone intercalated with basalt at Camel Back Mountain (NTS 21 O/9), 50 km west of Bathurst (Skinner, 1974). Conodonts recovered from several localities confirm the Arenig to Caradoc age range of the Tetagouche Group (Kennedy *et al.*, 1979; Nowlan, 1981a).

History: Gesner (1843) noted the manganese occurrence at Tetagouche Falls. Hitchcock (1861) extended his mica schist formation of Maine northeastward to the Woodstock area. Bailey (1864a, 1864b) examined the rocks along the Nepisiguit and Tetagouche rivers and Hind (1865) correlated them with the Québec Group. Robb (1870) mapped exposures along the southwest Miramichi River in central New Brunswick. He reported a brachiopod locality on a branch of Rocky Brook (a tributary of the Nashwaak River) which, because of its supposed Devonian age (it is now known to be Early Ordovician, Neuman, 1968, 1984), was considered to occur in an outlier within the older rocks. Ells (1881) discovered the Ordovician graptolite-bearing slate near the mouth of the Tetagouche River. He assigned most of the felsic volcanic rocks in the Bathurst area, however, to the Precambrian because of their similarity to those of the Coldbrook Group of southern New Brunswick. Bailey (1885, 1886) and Bailey and McInnes (1887) surveyed the rocks of west central New Brunswick. Bailey (1901) reported Early Ordovician graptolites on Eel River at Benton (NTS 21 G/13). Young (1911) referred to the Ordovician slates of the Bathurst area as the Tetagouche Series, a usage followed by Alcock (1935, 1941). Young (1910) considered the crystal tuff associated with iron formation on the Nepisiguit River to be a sill and referred to it as the Austin Brook quartz porphyry. Young (1918) described stratigraphic divisions along the southwest Miramichi River (NTS 21 J/10). Alcock (1941) suggested that volcanic rocks west of Bathurst previously considered to be Precambrian were probably Middle Ordovician because of their association with slate of the Tetagouche Series. Shaw (1936) recognized four divisions within the Cambrian-Ordovician rocks of the Sevogle River area (NTS 21 J/16) west of Newcastle. In 1949, the Geological Survey of Canada began mapping the Miramichi Highlands on a one-mile scale (Anderson, 1954a, 1954b, 1956, 1968, 1970a, 1970b; Anderson and Poole, 1959; Dawson, 1961; Helmstaedt, 1971; Poole, 1958, 1960, 1963; Skinner, 1953, 1956, 1975; Smith and Skinner, 1958; Smith *et al.*, 1973). Skinner and McAlary (1952) first used the term Tetagouche Group.

References: Alcock, 1935, 1941; Ami, 1906; Anderson, 1954a, 1954b, 1956, 1968, 1970a, 1970b; Anderson and Poole, 1959; Bailey, 1864a, 1864b, 1885, 1886, 1901, 1903, 1906a; Bailey and McInnes, 1887; Boyle and Davies, 1964; Dawson, 1961; Ells, 1881; Fyffe, 1976, 1977; Fyffe *et al.*, 1983; Gesner, 1843; Helmstaedt, 1971; Hind, 1865; Hitchcock, 1861; Kennedy *et al.*, 1979; Lea and Rancourt, 1958; Lutes, 1979; Neuman, 1968, 1984; Nowlan, 1981a; Poole, 1958, 1960, 1963; Rast *et al.*, 1976; Robb, 1870; Shaw, 1936; Skinner, 1953, 1956, 1974, 1975; Skinner and McAlary, 1952; Smith and Skinner, 1958; Smith *et al.*, 1973; Venugopal, 1978; Young, 1910, 1911, 1918.

A RECENT GRAPTOLITE DISCOVERY FROM THE FOURNIER GROUP OF NORTHERN NEW BRUNSWICK

Graptolites were recovered by L.R. Fyffe this summer from an exposure along the newly constructed section of Highway 11, 2.3 km to the west of the Belledune exit (GSC Locality 101732; Figure 12). The graptolites occur in black slate interbedded with mafic volcanic rocks of the Pointe Verte Formation. The Pointe Verte Formation forms the upper part of the ophiolitic Fournier Group (Rast and Stringer 1980).

The graptolites have been identified by John Riva of Laval University, who states that they belong to the *Nemagraptus gracilis* Zone (Figure 13). The forms identified are listed below:

Dicellograptus sp.
Climacograptus bicornis Hall? (tentative)
Dicranograptus sp.
Pseudoclimacograptus sp.
Didymograptus cf. *D. serratulus* Hall

The only previously known fossils from the Fournier Group are conodonts recovered from limestone in pillow basalts from the Pointe Verte Formation exposed in a roadcut on Highway 11 at the Pointe Verte exit (GSC locality 100240). This locality was collected by Bill Poole in 1982 and recollected by Godfrey Nowlan in 1984. Nowlan (1986) reports the presence of the following fauna which he states belong to the *Pygodus anserinus* Zone (Figure 13).

Ansella sp.
Microzarkodina sp.
Periodon aculeatus Hadding
Protopanderodus robustus (Hadding)
Pygodus anserinus Lamont and Lindstrom

As can be seen from Figure 13, the ages reported for the graptolite and conodont fauna are nearly identical and indicate that the age of the Pointe Verte Formation of the Fournier Group is Llandeilian to early Caradocian.

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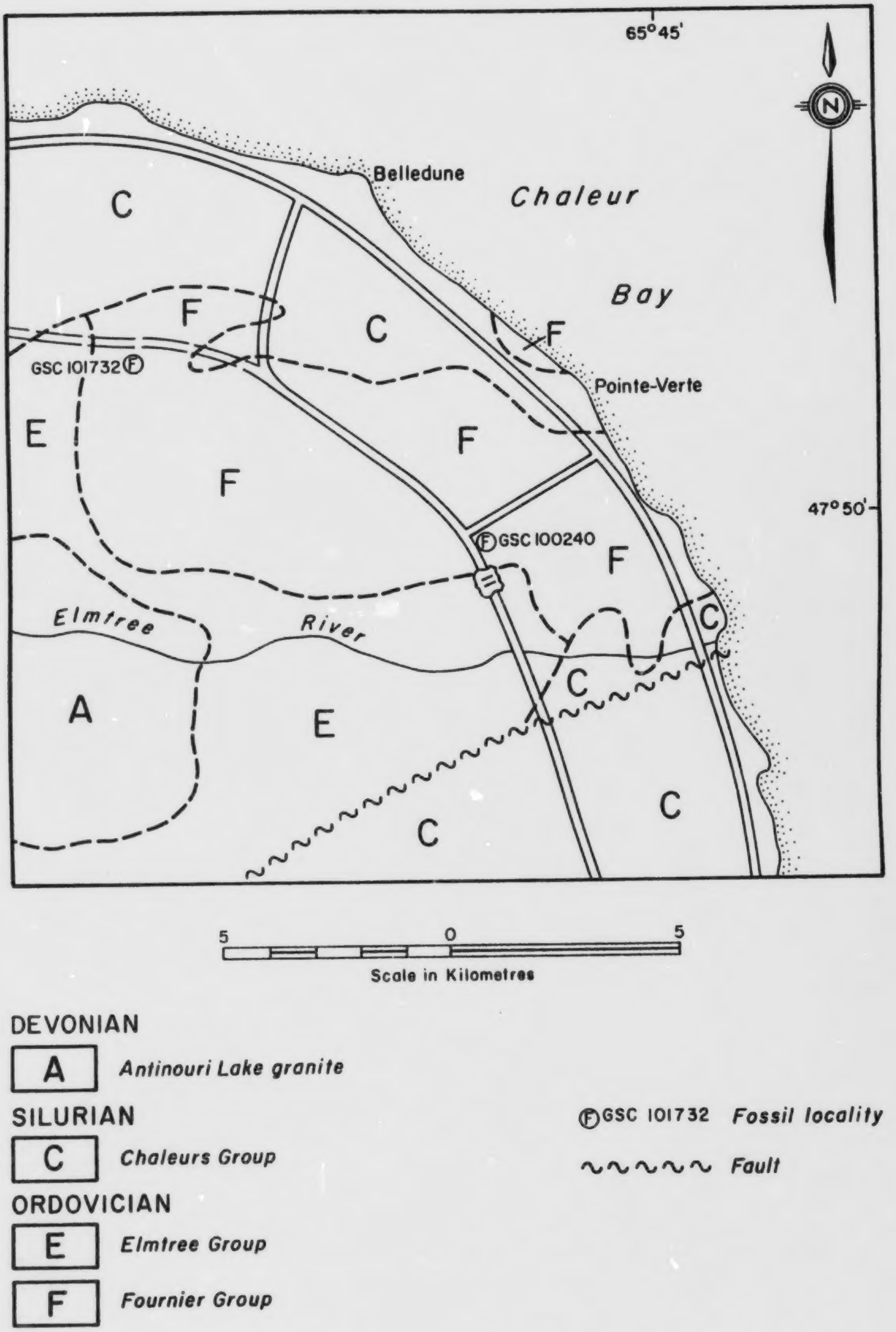

Figure 12. Geology of the Pointe-Verte area with fossil localities

	BRITISH SERIES	BRITISH AND SCANDINAVIAN GRAPTOLITE ZONES	NORTH ATLANTIC CONODONT ZONES
ORDOVICIAN	ASHGILLIAN	*Dicellograptus anceps*	*Amorphognathus ordovicicus*
		Dicellograptus complanatus	
		Pleurograptus linearis	
			Amorphognathus superbus
	CARADOCIAN		
		Dicranograptus clingani	
		Diplograptus multidens	
			Amorphognathus tvaerensis
		Nemagraptus gracilis	
			Pygodus anserinus
	LLANDEILIAN		
		Glyptograptus teretiusculus	
			Pygodus serrus
	LLANVIRNIAN	*Didymograptus murchisoni*	
			Eoplacognathus suecicus
		Didymograptus bifidus	
			Eoplacognathus variabilis
	ARENIGIAN	*Didymograptus hirundo*	
			Microzarkodina parva
			Paroistodus originalis
		Didymograptus extensus	
			Prioniodus navis
			Prioniodus triangularis
			Prioniodus evae
			Prioniodus elegans
		Tetragraptus approximatus	*Paroistodus proteus*
	TREMADOCIAN	*Clonograptus* and *Adelograptus*	
			Paroistodus deltifer
			Cordylodus angulatus
		Dictyonema flabelliforme and *Clonograptus*	
		Dictyonema flabelliforme	

Figure 13. Biostratigraphic zones for the Ordovician System

DRILL CORE MANAGEMENT

G.W. Crouse, Core Librarian

A new building capable of housing 200 000 feet (60 960 m) of drill core has been constructed on the site of the Sussex Regional Office. An inventory has been made of the core stored at the three regional offices. The Province has nearly 400 000 feet (121 920 m) of core in the Bathurst (Madran) repositories, 200 000 feet (60 960 m) at Sussex, and 125 000 feet (38 100 m) in Fredericton. About 103 000 feet (31 394 m) of core was donated to the Province by mining companies this year. Files are being prepared summarizing the drill-hole data, and this information is being computerized.

GEOCHEMISTRY LABORATORY

V. Rinco, Geochemical Analyst

Analyses were performed on 819 till samples from the Tetagouche Lakes area (NTS 21 O/9). Eight elements (Cu, Pd, Zn, Mn, Fe, Co, Ni, Ag) were analysed by atomic absorption and two (Sb, Mo), by colorimetry.

A total of 933 silt samples, collected in 1981, were analysed this year for Au, As, Sb, and Ba. These were taken from the Upsalquitch Forks (NTS 21 O/10), Tetagouche Lakes (NTS 21 O/9), Kedgwick (NTS 21 O/11), Serpentine Lake (NTS 21 O/2), and Sisson (NTS 21 O/6) map areas, and contained the necessary 15 gm (See Figure 14 for surveyed areas).

Approximately 27 000 silt samples kept at the Soils and Minerals Building, were previously stored according to the year collected. These have now been filed by NTS map area to better reflect their geographic distribution. These remaining samples will also be analysed for gold.

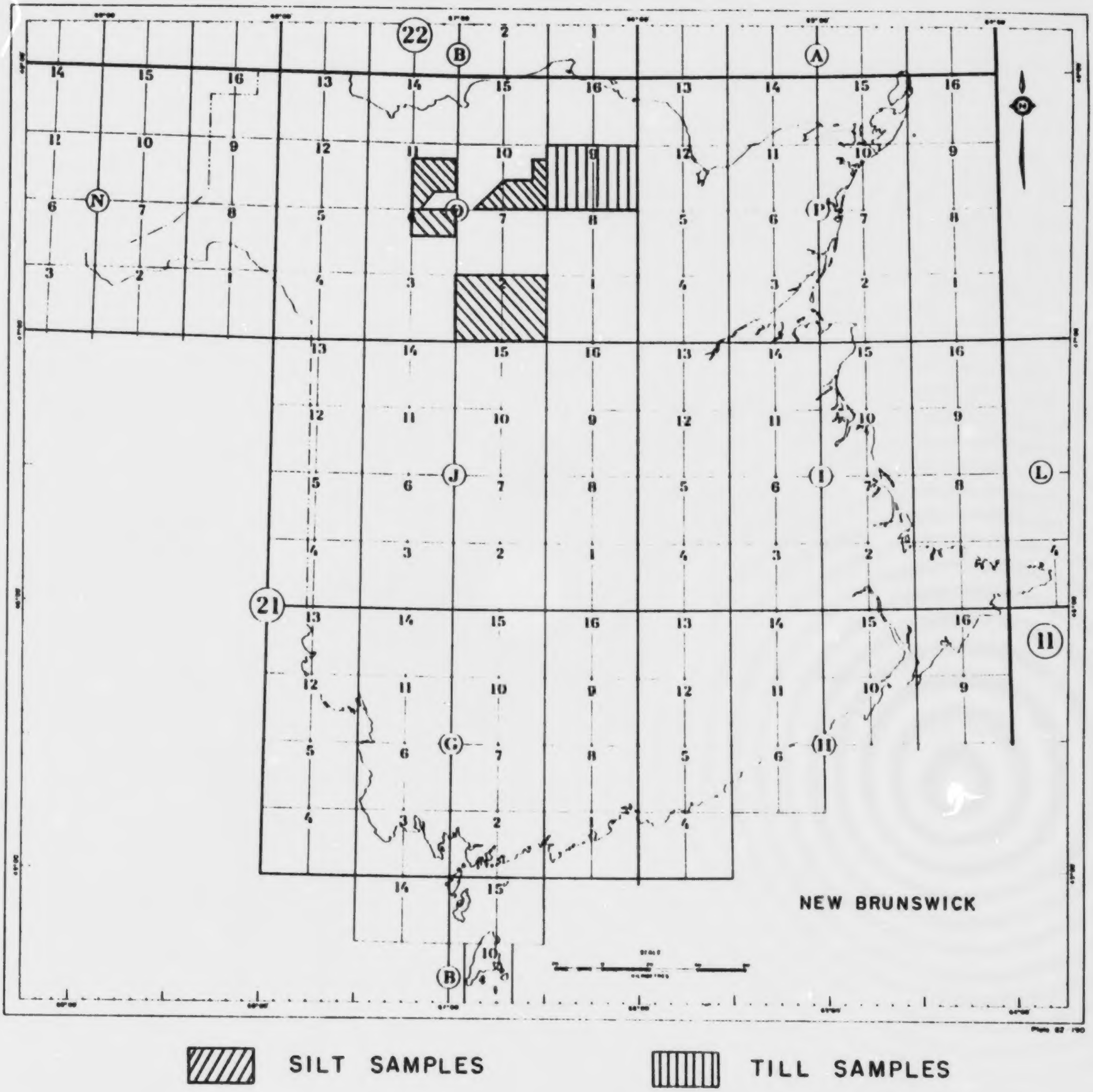

Figure 14. Location of silt and till samples

GEOLOGIC AND GEOCHRONOLOGIC INVESTIGATIONS OF THE BURNTHILL GRANITE

H.E. MacLellan (Project Geologist),
R.P. Taylor (Carleton University),
and D.R. Lux (University of Maine)

The Burnthill Granite is the largest in a cluster of five post-tectonic Middle Devonian plutons located within the Miramichi Highlands of central New Brunswick. These granites and associated mineral deposits are the subject of an ongoing petrogenetic study (MacLellan 1985; Gardiner and Garnett, this publication).

Recent work has confirmed that the Burnthill Granite is a multiphase, high silica granitic pluton emplaced at shallow crustal levels. The two main phases are a coarse-grained seriate granite in the north and a medium-grained equigranular granite forming two lobes in the south (Figure 15). The northern contacts of the equigranular granite with the seriate granite are gradational, but the southern contacts are sharp. Similarly, a fine-grained facies of the equigranular granite has both gradational and sharp contacts with the medium-grained equigranular granite. These contact features between three phases with very similar chemistries suggest that all have crystallized from a single, zoned magma chamber that has undergone a complex cooling history involving localized remobilization of the magma.

Petrographic studies have provided evidence for the origin of the various phases. Hypersolvus alkali feldspars from the coarse-grained seriate granite contain abundant perthitic lamellae and no development of microcline twinning. As grain size decreases, from north to south, the proportion of perthitic lamellae in the alkali feldspars decreases, and microcline twinning is more frequently developed. These are strong indicators that the temperatures of crystallization decreased from north to south. The close association between the equigranular granites and mineral occurrences (Figures 15, 16) leads to the conclusion that collection of fluids in the south resulted in late crystallization of the magma in thatlarea. Field relations are consistent with the interpretation that the mineral deposits were formed from fluorine-rich magmatic fluids. The fluids were originally concentrated near the roof zone of the magma chamber, which has been subsequently tilted toward the south. Brittle fracture of the cooling granite allowed escape of the fluids along fractures, leading to the development of several mineral occurrences (Figure 15).

Late-stage pods and dykes of granite porphyry, aplites and granophyric granites are considered to be derived from the coarse-grained seriate granite, but intrude all other rock types. Their formation may be due to local perturbations of fluid concentrations and thermal conditions within the magma chamber. Resulting pockets of phenocryst-bearing, late-crystallizing magmas were then tapped by brittle fractures developed in the cooling pluton.

The relationship of the melanocratic biotite granite (Figures 15, 16) to the coarse-grained seriate granite is uncertain; the melanocratic granite crystallized before the equigranular granite and contains dykes of granite porphyry and aplite.

Previous geochronologic investigations of the Burnthill Granite have yielded conflicting results as shown in Table 2. Consequently, a different technique, $^{40}Ar/^{39}Ar$ age spectra determined for phyllosilicate mineral separates, has been tried in order to: 1) evaluate the utility of this technique in geologic environments of this type, and 2) provide data on the absolute chronology of granite intrusion and hydrothermal mineralization in the Burnthill area. Some of the data are shown in Figures 16, 17. Sample descriptions are given in Table 3. Additional data and a detailed interpretation of the results will be published in the near future.

Plateau ages (tp) were obtained from all of the muscovite mineral separates (Figure 17) suggesting an age of 379±4 Ma for late-stage magmatic activity (DDH-WM81-2A-83.5) and ages of 383±5 Ma and 379±3 Ma for hydrothermal alteration at Burnthill tungsten mine (ALD-7 and DDH-BH12-310). These ages are the same, within the limits of experimental error. The biotite spectra showed more variation (Figure 17). A plateau age of 386±5 Ma was obtained from a coarse-grained granite (BH85-49b) showing no apparent effects of surface weathering or hydrothermal alteration. Two other granite samples (BH85-45 and -135) with no hydrothermal alteration effects and minimal surface weathering effects, did not yield plateau spectra, but did give total gas ages (tg) of 377 and 379 Ma, in general agreement with those cited above. The remaining three biotite separates (BH85-173b, DDH-BH8-283.5, and DDH-BH3-85) did not yield plateau spectra and had significantly lower total gas ages of 366, 354, and 365 Ma, respectively. These young apparent ages are considered to be the result of hydrothermal alteration of the magmatic biotites.

$^{40}Ar/^{39}Ar$ plateau ages for biotites and muscovites from the Burnthill Granite and associated mineralization are in agreement with those obtained from previous K/Ar studies. On this basis, a tentative age of 380±5 Ma (Middle Devonian) is assigned to the Burnthill Granite and the mineral deposits considered to be derived from it. Disturbance of several biotite spectra was caused by surface weathering and/or hydrothermal alteration.

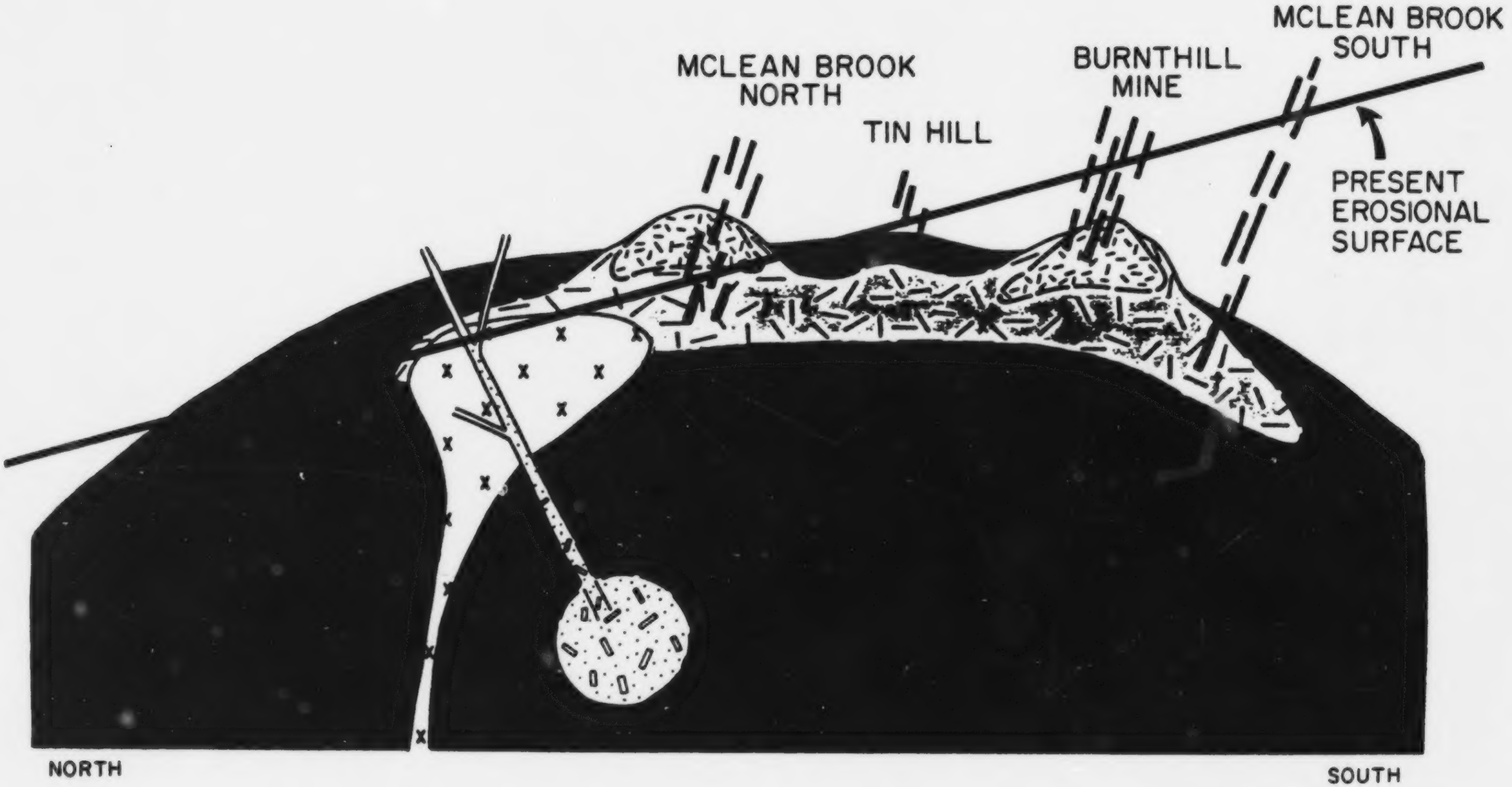

Figure 15. Schematic cross section of the Burnthill Pluton

LEGEND

BURNTHILL GRANITE

░	*PORPHYRY DYKES, GRANOPHYRIC GRANITE AND APLITE*
■	*EQUIGRANULAR GRANITE; MEDIUM-GRAINED AND FINE-GRAINED*
■	*COARSE-GRAINED GRANITE; PORPHYRITIC BORDER PHASE*
⊠	*PORPHYRITIC MELANOCRATIC BIOTITE GRANITE*
■	*SUBOPHITIC GABBRO*

COUNTRY ROCKS

□	*UNDIVIDED ORDOVICIAN TO DEVONIAN ROCKS*

SYMBOLS

/ ⁄	*GEOLOGICAL CONTACT (ABRUPT, GRADATIONAL)*
///	*MINERALIZED QUARTZ VEINS AND GREISEN-BORDERED VEINS*

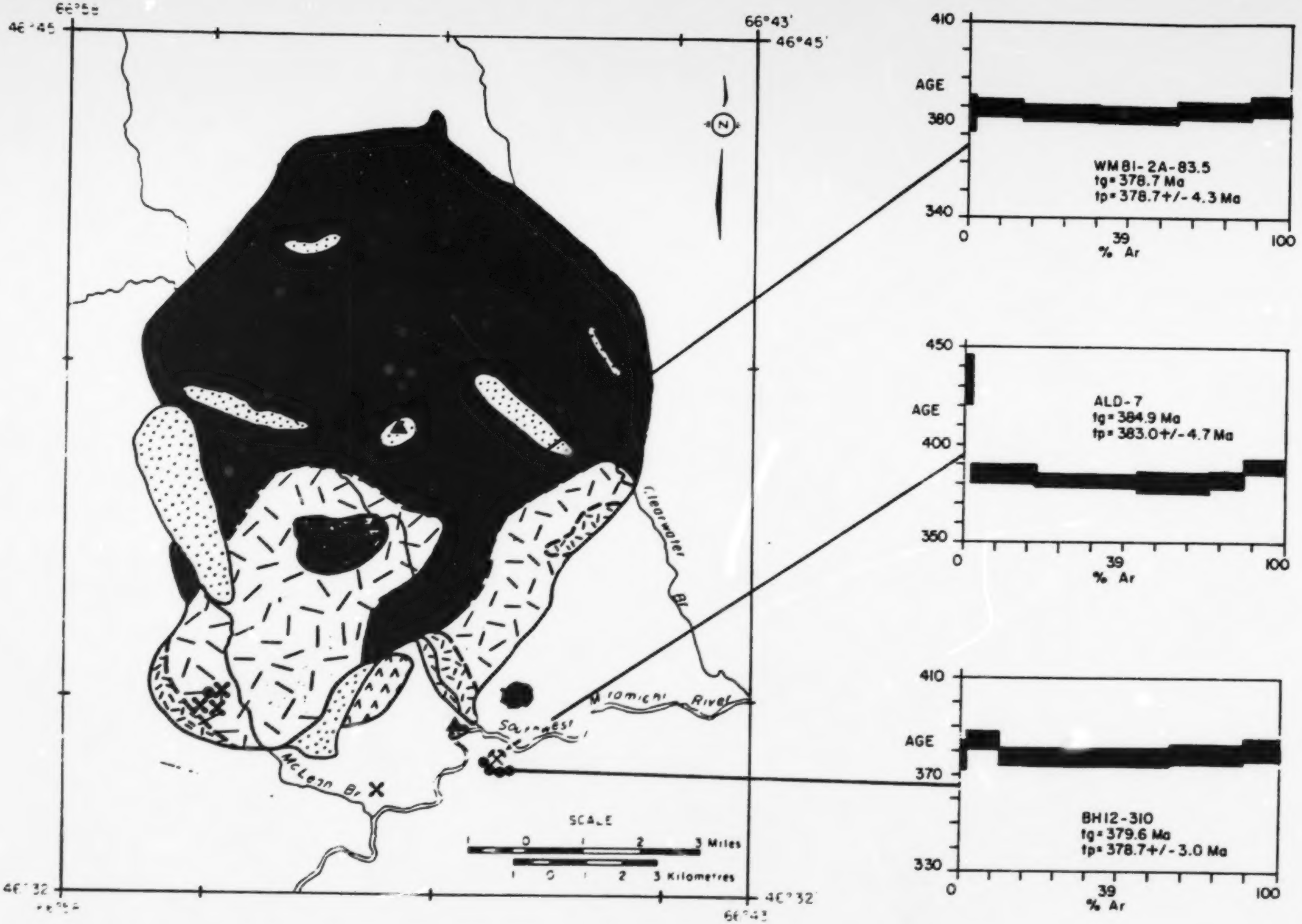

Figure 16. $^{40}Ar/^{39}Ar$ ages of muscovite from Burnthill Granite

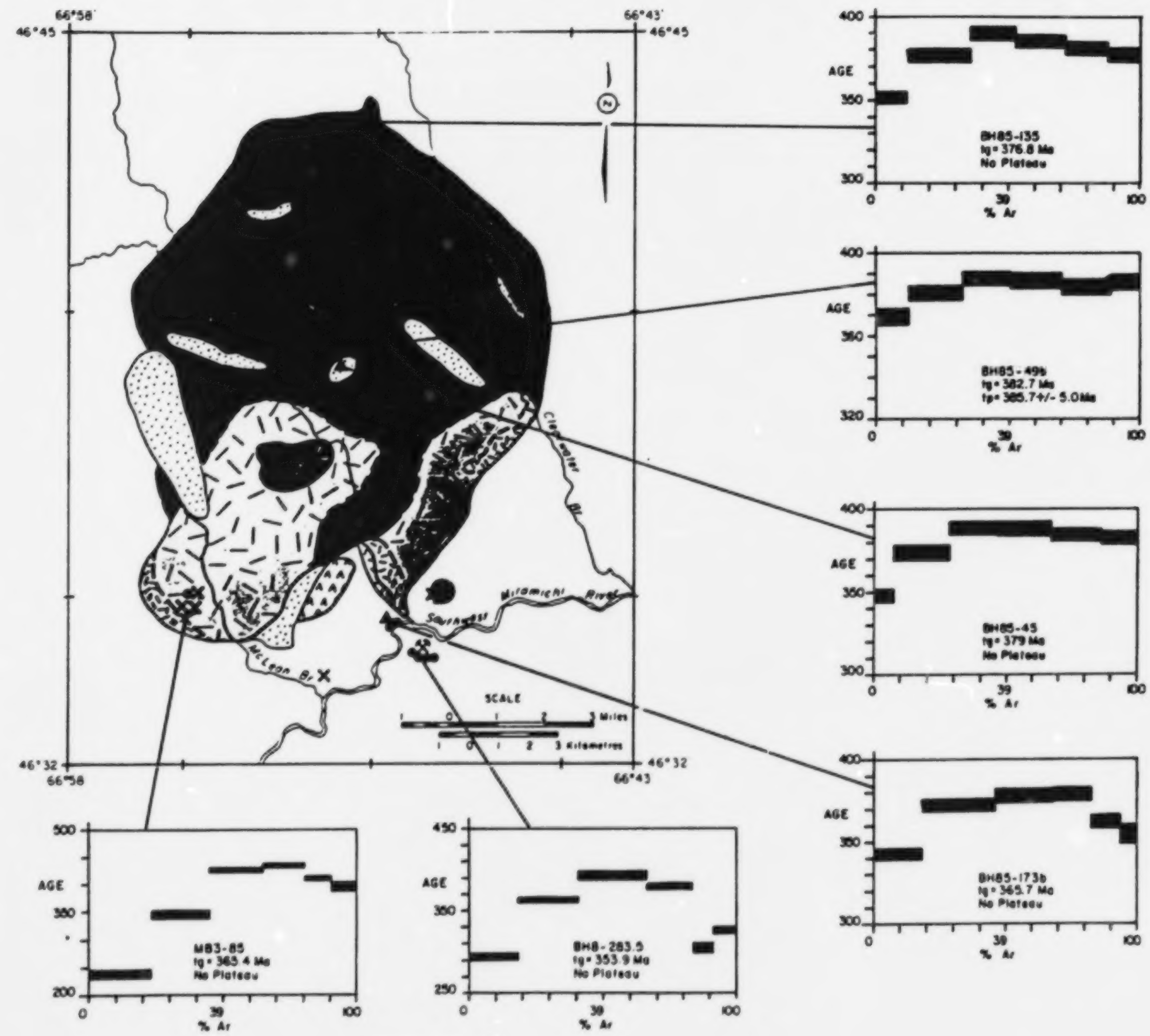

Figure 17. $^{40}Ar/^{39}Ar$ ages of biotite from the Burnthill Granite

Table 2

Previously Determined Radiometric Ages
of the Burnthill Granite

Lithology	Method	Mineral(s) Dated	Age (Ma)	Reference
Equigranular granite	K/Ar	Biotite	346*	Lowden *et al.* (1963)
Greisen-bordered vein; Burnthill Tungsten Mine	K/Ar	Muscovite	382±26*	Potter (1969)
Quartz-muscovite fissure vein; Burnthill Tungsten Mine	K/Ar	Muscovite	377±15*	Wanless *et al.* (1967)
Various granite samples from the northern end of the Burnthill Granite	Rb/Sr isochron	Whole Rock	351±8	Crouse (1981)
Altered granites and greisen; Burnthill Tungsten Mine	Rb/Sr isochron	Whole Rock	260±12	unpublished

*These dates have been corrected using the new decay constant reported by Dalrymple (1979).

The two Rb/Sr isochrons are suspected to be pseudo-isochrons that do not reflect true ages of crystallization. Some of the samples used for the 351 Ma isochron showed surface weathering effects, a well-documented source of error in Rb/Sr whole-rock studies. Although the 260 Ma Rb/Sr age from the greisenized granite may date the time of hydrothermal alteration at the Burnthill Tungsten Mine, this is considered unlikely given the known field relationships and consistent ^{40}Ar/^{39}Ar ages from both quartz-muscovite veins and greisenized granite. Further geochronologic studies are planned in order to resolve these apparent conflicts.

Table 3

Description of Samples

for $^{40}Ar/^{39}Ar$ Age Determinations

Sample No.	Latitude	Longitude	Mineral Dated	Sample Description
85-BH-135	46°43'28"	66°49'45"	Biotite	Medium-grained porphyritic biotite granite; border phase of the coarse-grained subporphyritic granite; incipient development of exfoliation fractures associated with surface weathering; minimal weathering of biotite
85-BH-49B	46°39'18"	66°51'05"	Biotite	Coarse-grained subporphyritic granite; no apparent surface-weathering or other alteration effects; fresh biotites
85-BH-45	46°39'18"	66°50'57"	Biotite	Late-stage porphyry dyke cutting coarse-grained subporphyritic granite; no apparent surface-weathering or other alteration effects; fresh biotites
85-BH-173b	46°34'30"	66°49'26"	Biotite	Fine-grained equigranular biotite granite; sample from cupola near contact with country rocks; partial breakdown of biotite caused by some combination of surface weathering and hydrothermal alteration caused nearby greisen-bordered veining
DDH-BH8-283.5	46°34'07"	66°48'37"	Biotite	Fine-grained equigranular biotite granite from drill core; partial breakdown of biotites caused by hydrothermal alteration associated with Burnthill Tungsten Mine.
DDH-MB3-85	46°35'03"	66°54'30"	Biotite	Fine-grained equigranular biotite granite from drill core; partial breakdown of biotites caused by hydrothermal alteration associated with McLean Brook North mineral showing
DDH-WMB1-2A-83.5	46°37'48"	66°49'25"	Muscovite	Late-stage aplite dyke cutting coarse-grained subporphyritic granite from drill core (drilled by Western Mines during a uranium exploration program); fresh muscovites
ALD-7	46°34°08"	66°48°40"	Muscovite	Quartz-muscovite vein from ore dump at Burnthill Tungsten Mine; fresh muscovites
DDH-BH12-310	46°34'07"	66°48'37"	Muscovite	Greisen-border alteration of granite adjacent to quartz-vein in drill core from Burnthill Tungsten Mine; fresh muscovites

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A FIELD INVESTIGATION OF GRANITES IN THE DUNGARVON AREA OF NEW BRUNSWICK

W.W. Gardiner and K. Garnett, Field Geologists

The objective of the Burnthill Project within central New Brunswick (21 J/10) is to determine the petrochemical evolution of the Late Devonian granites and associated tin-tungsten mineralization in order to develop criteria that will aid in the exploration for similar types of deposits. The project began in June, 1985 with the field mapping of the Burnthill Granite. In 1986, the field work was completed on the Dungarvon and Sisters Brook granites. This project is funded through the Canada-New Brunswick MDA.

Several granitic phases have been outlined, as shown on the preliminary map of the 1986 field area (Figure 18). Units 1 and 2 comprise the various igneous and sedimentary country rocks. The main phase of the Dungarvon Granite (Unit 3) contains a variety of textural variants that can be considered comagmatic. The bulk of Unit 3 consists of a medium- to coarse-grained seriate biotite granite that is coarsest to the northwest and at the lower elevations along the Dungarvon River. A fine-grained marginal phase is locally present.

Unit 4 consists of a medium-grained porphyritic biotite granite characterized by a relatively high biotite content (about 5%), coarse feldspar phenocrysts and, at least locally, by a higher plagioclase content. The contact relationship with Unit 3 is not exposed. Muscovite occurs locally as an accessory mineral and in miarolitic cavities.

Unit 5 is a medium-grained, equigranular biotite granite (with muscovite in the Trout Brook area), that locally contains quartz phenocrysts, particularly near its contact with Unit 3; feldspar phenocrysts are scarce. Unit 5 has been observed in boulders to intrude Units 3 and 4. Muscovite occurs in proximity to known greisen veins and is therefore probably of secondary origin. Miarolitic cavities, many of which are open or fluorite-filled, are common. The finer grained portions of Unit 5 grade into locally mineralized feldspar±biotite lenses. These lenses are mainly confined to Unit 5, but they also cut older units where they exhibit sharp contacts.

Unit 6 comprises a number of dyke phases, represented by quartz-feldspar porphyry, aplite, and composite (fine- to medium-grained) dykes. Generally, these dykes are seen to postdate Units 3 to 5.

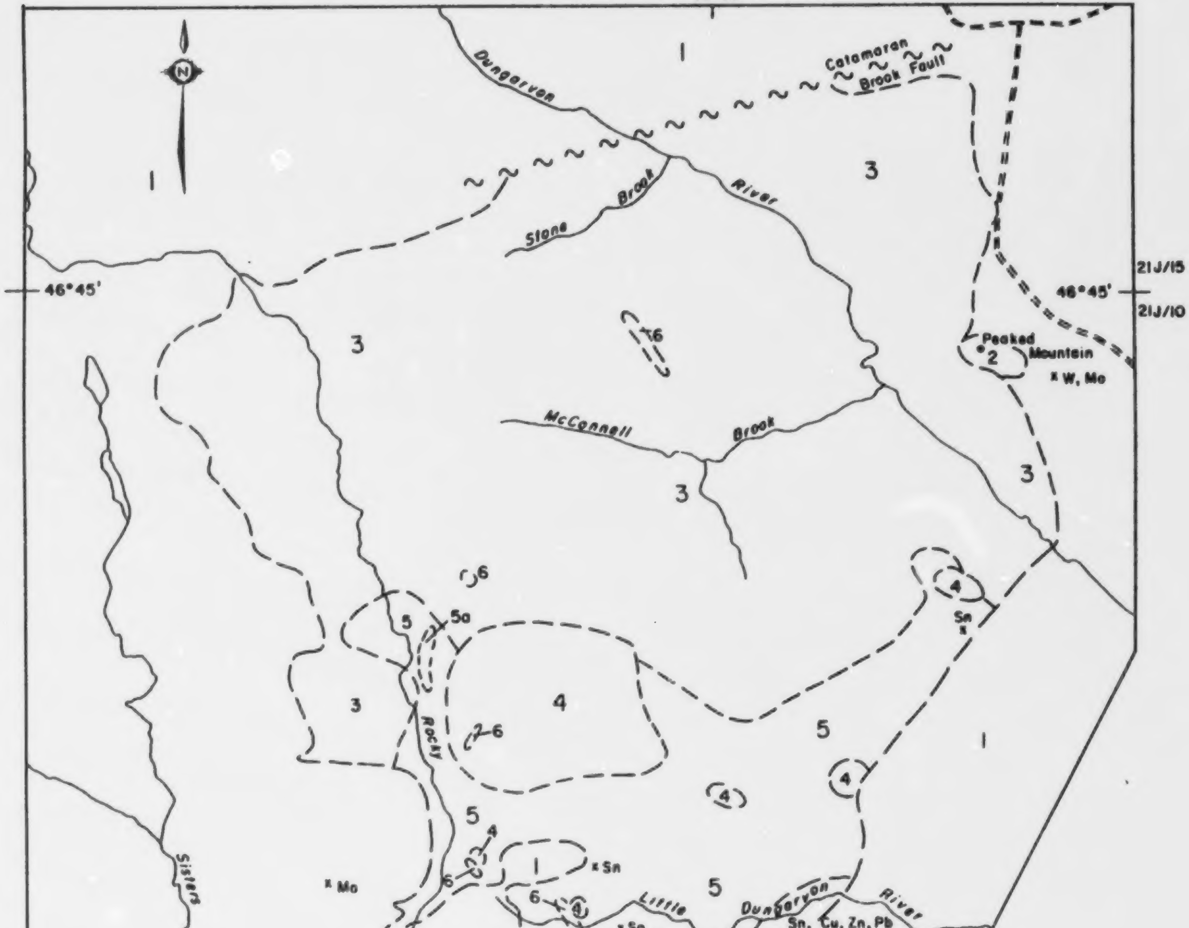


Figure 18. Preliminary geology map of the Dungarvon Granite

LEGEND

UPPER DEVONIAN

6	Quartz-feldspar porphyry and associated aplite
5	Medium-grained, locally miarolitic, equigranular biotite granite, with local secondary muscovite; 5a is a crowded porphyry phase
4	Medium-grained porphyritic biotite-rich granite
3	Coarse-grained seriate biotite granite

LOWER DEVONIAN

2	Massive to subophitic gabbro

LOWER DEVONIAN AND OLDER

1	Country rocks, including Ordovician granites and Cambro-Ordovician metasediments and metavolcanics of the Tetagouche Group

SYMBOLS

— — —	Geological boundary
x ▲	Metallic mineral showings - vein, greisen: tin (Sn), molybdenum (Mo), tungsten (W), bismuth (Bi), copper (Cu), zinc (Zn), lead (Pb)

The Sisters Brook stock is essentially comprised of medium-grained, equigranular quartz-porphyritic biotite granite of Unit 5 with a marginal, medium- to coarse-grained feldspar porphyritic biotite granite of Unit 3.

Metallic mineral occurrences (primarily tin, tungsten, and molybdenum) are of several types. The feldspar pods originating in Unit 5 frequently contain fluorite, epidote, pyrite, and/or cassiterite as disseminations or vug infillings (e.g., Little Dungarvon River area). These appear to evolve into cassiterite veins cutting feldspar pods (e.g., Four Mile Brook area), to quartz-feldspar-cassiterite veins (e.g., Little Dungarvon River area) to endo- and exogranitic quartz-cassiterite± feldspar veins (e.g., lower Rocky Brook area), to quartz (barren) veins. Cassiterite in greisenized granite is generally restricted to the Trout Brook and lower Rocky Brook areas, although minor occurrences exist at the Cleveland showing and in boulders west and northwest of Peaked Mountain.

Tungsten occurs as wolframite in endo- and exogranitic veins in association with greisenization in the lower Rocky Brook area and west of Peaked Mountain (boulders only), and as scheelite in the exogranitic sheeted vein system east of Peaked Mountain. Molybdenite commonly occurs in association with the tungsten mineralization. Molybdenite also occurs, in minor amounts, as disseminations, stringers, and in quartz veins throughout the area, locally associated with bismuthinite.

NEW DENMARK PROJECT

R. Wilson, Project Geologist

A geological survey at 1:20 000 was undertaken in the New Denmark area (portions of NTS sheets 21 J/13, J/14, O/3, O/4) to provide a more detailed geologic map of the area, and to evaluate the mineral potential of the volcanic rocks (Figure 19).

The project area is located between Plaster Rock and Grand Falls, Victoria County, and is underlain by Siluro-Devonian mafic and felsic volcanic and sedimentary rocks. These units are situated between the Upper Ordovician-Lower Silurian Matapedia Group limestone to the west, and Mississippian redbeds of the Plaster Rock Basin to the east.

Results of preliminary mapping suggest that outcrop distribution is controlled by a major fold structure - the Hazeldean anticline. The core of this "dome" is occupied by dark grey, fossiliferous, calcareous to noncalcareous siltstones and fine-grained sandstones (Unit Ss_1; Figure 19), that plunge beneath the volcanic rocks to the north. This distinctive unit contains abundant fossils in most outcrops and is characterized by thin beds and parallel laminations of buff-brown-weathering sandstone. Dating of previously collected fossil assemblages has determined a Llandovery (Lower Silurian) age for at least some of these sediments.

Conformably(?) overlying the siltstone unit to the north, and forming the horseshoe-shaped closure of the Hazeldean anticline, is a succession of felsic flows and tuffs (Units Sfv_1 and Sfv_2), mafic flows (Unit Smv) and minor polymictic conglomerate (Unit Spc), green siltstone and fine-grained sandstone (Unit Ss_2). On the east flank of the Hazeldean anticline, these units disappear beneath the unconformably overlying Mississippian redbeds (Unit Ms), but to the south they are truncated by the east-northeast-trending Blue Bell fault. To the west, rhyolite can be traced as a prominent topographic high for some distance, where it too apparently pinches out south of Blue Bell Mountain. Basalt can be traced intermittently for several kilometres along the western flank of the anticline, but scarcity of outcrop and the obscuring Mississippian cover inhibit detailed mapping of this unit south of the Blue Bell fault.

Felsic rocks occur in two horizons (Units Sfv_1 and Sfv_2) separated by mafic volcanic rocks. The felsic volcanics are generally flow banded, although massive aphanitic rhyolites, ash and lapilli tuffs, and fine-grained porphyries also occur. Volcanogenic conglomerates containing rhyolite pebbles are locally observed interbedded with the felsic flows of Unit Sfv_1. Polymictic conglomerates (Unit Spc) containing

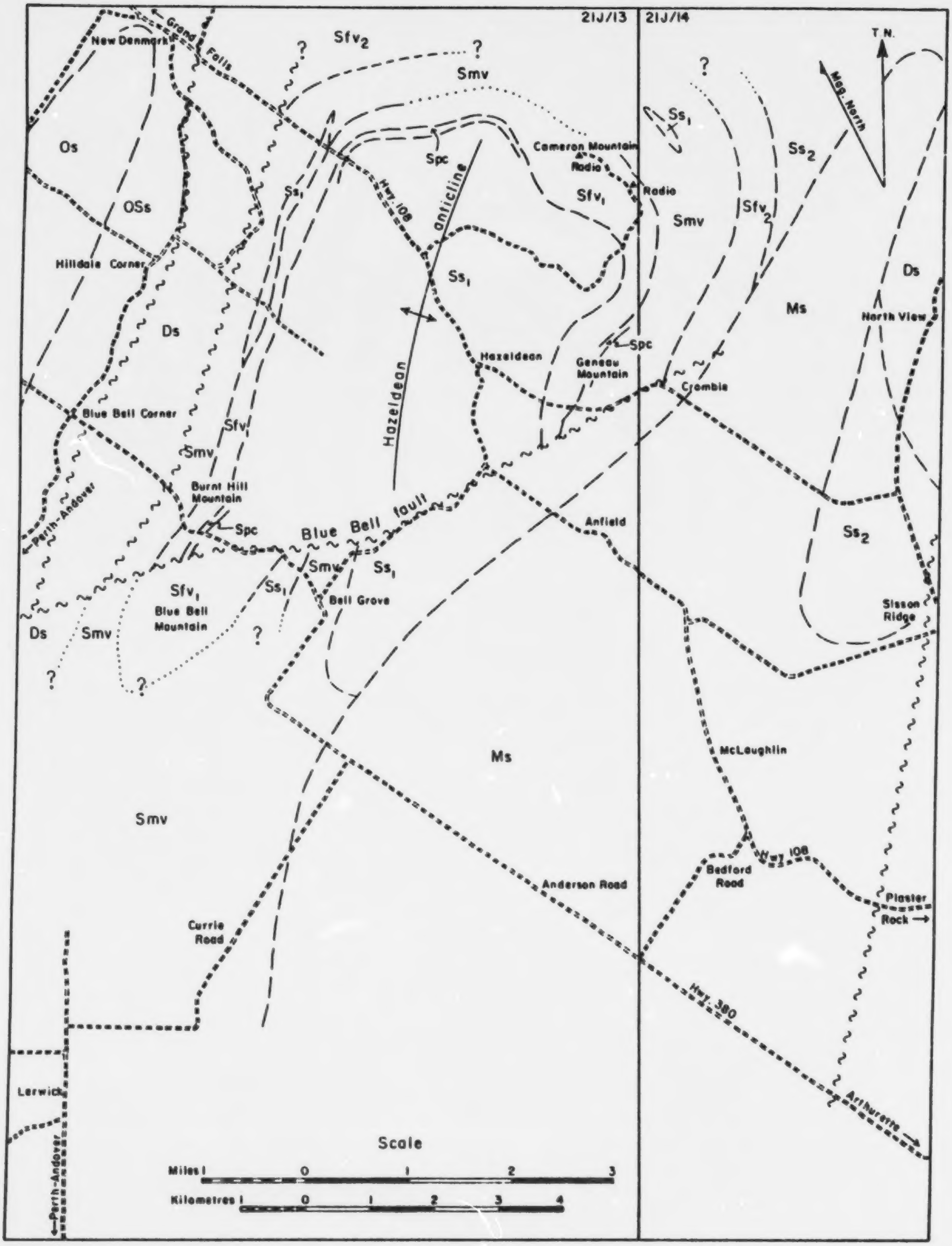


Figure 19. New Denmark Project

LEGEND

MISSISSIPPIAN

Ms Arthurette Redbeds: red sandstone and conglomerate

DEVONIAN

Ds Wapske Formation: grey quartzose sandstone, siltstone; dark grey argillaceous sandstone and siltstone, minor mudstone

SILURIAN

Ss_2 Olive green siltstone, fine-grained sandstone, shale

Sfv_2 Pink to buff-orange felsic flows, minor intermediate flows

Smv Olive green to dark green pillow basalts, dark green fine-grained mafic flows, minor intermediate to felsic rocks

Sfv_1 Pink, orange, buff to brown felsic flows, ash and lapilli tuffs, fine-grained feldspar porphyries, minor agglomerate, tuffaceous sediments, and volcanogenic conglomerates

Spc Polymictic pebble and cobble conglomerate

Ss_1 Dark grey, typically fossiliferous, calcareous to noncalcareous siltstone and fine-grained sandstone; includes younger rocks of same lithologies interbedded with felsic and mafic volcanics

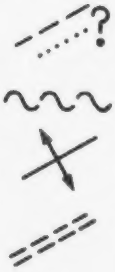
ORDOVICIAN-SILURIAN

OSs Matapedia Group: grey calcareous slate, grey to black aphanitic limestone, interlaminated calcareous slate and limestone

ORDOVICIAN

Os Grog Brook Group: dark grey slate, lithic wacke, polymictic conglomerate

SYMBOLS



Geological contact (defined, assumed)

Fault

Anticline

Main road

some pebbles of volcanic material show a close spatial association with Unit Sfv_1, and are found both above and below this unit. Mafic volcanics are typically olive green to very dark green, fine grained, and are commonly pillowed. Vesicular pillow basalt and dark green massive basalt are approximately equally distributed, while amygdaloidal varieties are less common, and scoriaceous horizons marking the tops of individual flows are rare. Autobrecciation and contemporaneous extrusion of felsic and mafic flows has locally produced agglomeratic rocks. Gabbro was observed in angular floats on the Currie Road and is assumed to occur as a small stock, since aeromagnetic data shows a small circular anomaly at that location. Pyrite mineralization has been noted at a few locations in both rhyolite and basalt. One outcrop of basalt east of Cameron Mountain is brecciated, altered, and mineralized with pyrite and botryoidal manganese nodules.

In the extreme northeast part of the map area, unconformably underlying the Mississippian redbeds, are several exposures of olive green, nonfossiliferous siltstone, fine-grained sandstone, and shale (Unit Ss_2). In the absence of fossils, it is assumed that these rocks are the youngest in the Silurian sequence, since all units are right-way-up and there are no major folds east of the Blue Bell anticline.

To the west, a belt of blue-grey, brown-weathered quartzose and locally fossiliferous sandstones and siltstones, interbedded with dark grey argillaceous sandstones, siltstones, and minor mudstones (Unit Ds) is interpreted to be in fault contact with the Silurian mafic volcanic rocks. This unit has been assigned a Devonian age on the basis of similarity to Devonian rocks to the north and south. Additional mapping is expected to define the relationship of this unit to the sedimentary and volcanic rocks of the Hazeldean anticline. These Devonian rocks are in fault contact with limestone of the Matapedia Group (Unit OSs) farther to the west. Clastic turbidites of the Grog Brook Group (Unit Os) underlie the Matapedia Group.

Within the core of the Hazeldean anticline, minor folding can be seen within individual siltstone outcrops, and is also interpreted to be present on the basis of changes in bedding attitudes between adjacent outcrops. These folds are gentle to open to close, typically asymmetrical, and plunge gently to the north and south. The slaty cleavage, axial planar to these folds, generally strikes northeast and dips steeply to the east or west, although trends may vary from north-south to almost east-west.

Petrographic examinations and whole-rock geochemical analyses of selected samples will be carried out in conjunction with the field work. In addition, numerous bulk samples of fossils have been collected from the sedimentary units.

SURFICIAL GEOLOGY AND GEOCHEMISTRY OF UPSALQUITCH FORKS (NTS 21 O/10)

A.G. Pronk, Project Geologist

The Upsalquitch Forks area was mapped and sampled during the 1986 field season in order to obtain information on tills in the vicinity of the Rocky Brook-Millstream Fault. This fault zone is known to be related to gold mineralization in the Elmtree area northwest of Bathurst. There, the fault separates conglomerates of the Silurian Chaleurs Group to the south from Ordovician slates of the Elmtree Group to the north. A sheared and altered gabbroic dyke within the fault zone contains 0.10 to 0.31 oz./ton (3.43 to 10.63 g/t) of gold across widths of 1.0 to 6.5 feet (0.3 to 2.0 m). Gold occurrences have recently been discovered in the Upsalquitch Forks area and are apparently related to splays off the Rocky Brook-Millstream fault system. These occurrences are found within silicified dykes of intermediate composition and within silicified and pyritized zones within adjacent calcareous siltstones of the Chaleurs Group. Values of up to 0.23 oz./ton (7.89 g/t) of gold over 3.3 feet (1.0 m) have been reported.

Previous surficial mapping and till geochemistry in the Tetagouche Lakes area (NTS 21 O/9) confirmed the relation between the Rocky Brook-Millstream fault zone and the presence of gold in northern New Brunswick (Pronk 1985). Gold anomalies in tills were found along the fault boundary between sedimentary rocks of the Chaleurs Group in the south and Devonian mafic volcanic rocks of the Dalhousie Group to the north. Not all anomalies were associated with this fault zone, however. Some were located along the contact between Silurian felsic and mafic volcanic rocks to the north of the Rocky Brook-Millstream Fault and within Ordovician felsic metavolcanic rocks of the Tetagouche Group to the south of Forty Mile Brook. A total of 48 out of 266 samples in the Tetagouche Lakes area were highly anomalous in base metals and gold-pathfinders. Although only 12 of these samples indicated the presence of gold, the other anomalous sites should be considered for further investigation. Anomalous values of pan-concentrated samples ranged from 6 to 619 ppb Au (Pronk 1986).

The tills in the Upsalquitch Forks area (Figure 20) are generally thin, often not more than 0.5 m, probably as a result of their proximal position to the ice-centre (Northern Maine-Notre Dame - Ice Divide) where erosion dominated over deposition. In the northwestern half of the area, tills are fine, sandy, and contain mainly sedimentary rocks derived from the Upper Ordovician to Silurian Matapedia, Chaleurs, and Grog Brook groups (calcareous siltstones, wackes, limestones, etc.). Tills in the southeastern half of the area are similar

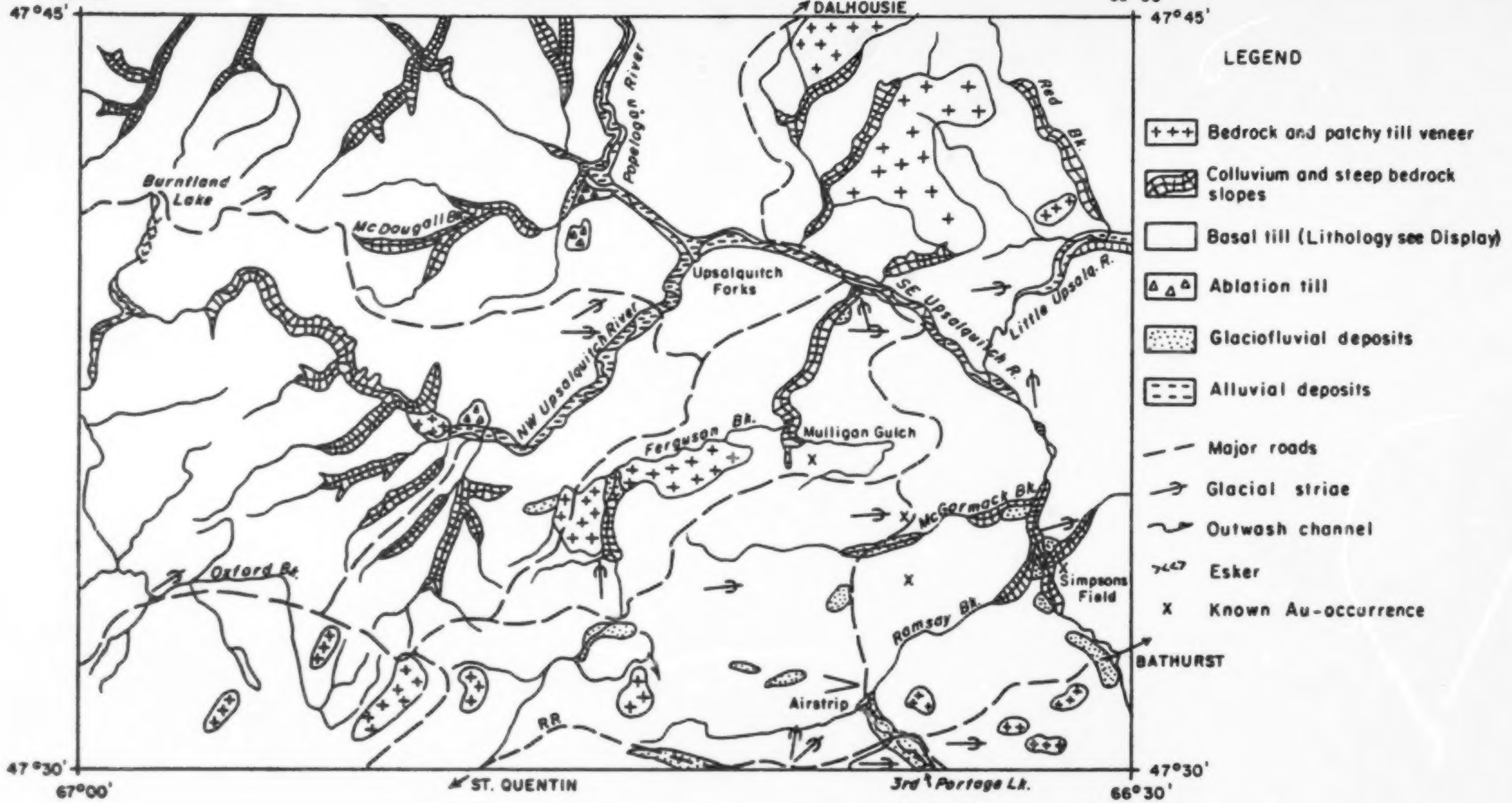


Figure 20. Surficial geology of Upsalquitch Forks map area (21 O/10)

to those in the northwestern half of the adjoining Tetagouche Lakes area and contain mainly Silurian and Devonian sedimentary and volcanic rocks. A total of 266 sites were sampled (B and C horizons) on a regular 2 km grid. For each site, a soil profile was described and a vegetation inventory was carried out for forest site classification.

The main ice movement in the Upsalquitch Forks area was in an easterly direction as recorded in erosional features such as striae, whale backs, crag and tail, etc. Few ice movement indications were recorded in the eastern part of the region probably as a result of the deeply weathered nature of the calcareous bedrock when ice moved through the area. Indications of a secondary northeasterly ice movement are present in striae, till fabric, and striated boulders in till. In places, till with striated boulders (40-60°) overlies easterly striated outcrop. Striations and fabric that indicate a northward ice movement are locally present, but age relationships were not clear and definite. Proof for a late-stage northward flow is still being sought. This proposed late-stage movement would indicate redirection of the ice mass similar to that in northern Maine which was initiated by drawdown of the ice mass into the St. Lawrence valley. A similar drawdown into Chaleur Bay could have taken place in northern New Brunswick and would have left the Northern Miramichi Highlands as a nunatak zone as postulated by Seaman (1985). No signs of "glacial Lake Upsalquitch" were found, although several side-valleys contain a significant amount of ice-contact material that would imply late-stage ice occupying the Upsalquitch valley.

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GEOSCIENCE DATA CENTRE

GEOSCIENCE DATA CENTRE ACTIVITIES

D.J.J. Carroll, Coordinator

In early 1986 the Geological Surveys Branch was reorganized so that the Geoscientific Editorial Section became part of the Geoscience Data Centre (Figure 21). The addition of this section brought together all people concerned with the cartographic production of maps and drawings, the technical editing of geoscientific documents, and the dissemination of these publications to the general public and mineral industry.

As in the previous year, because of the Canada-New Brunswick MDA (1984-89), the Geoscience Data Centre was involved in projects related to the Public Information, Awareness, Administration Program under the MDA.

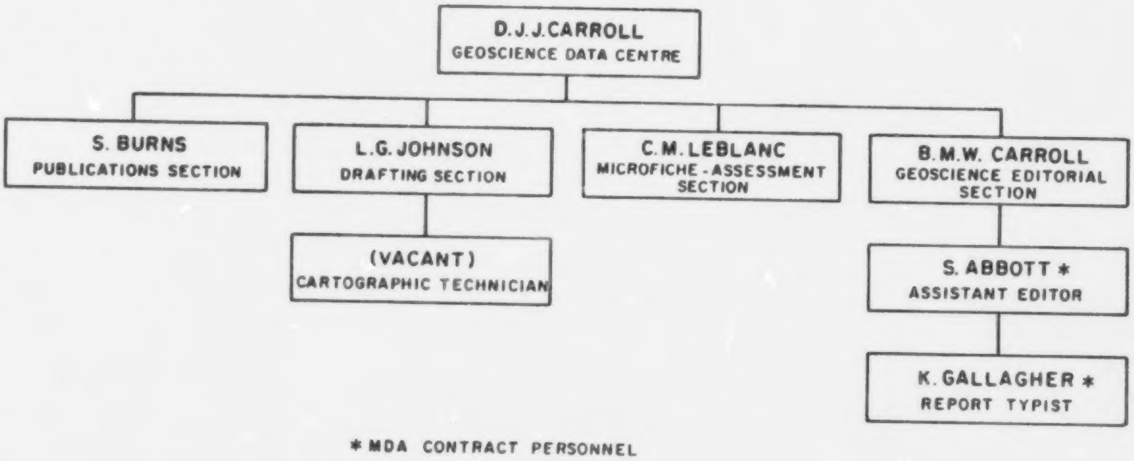


Figure 21. Organization chart

A brief synopsis of the 1986 activities of the Geoscience Data Centre is described below.

GEOSCIENCE EDITORIAL SERVICES

The responsibilities of this unit are to edit all geoscientific reports and maps that are produced by or for the Mineral Resources Division. Because of the increased workload from projects conducted under the MDA, two people, an assistant editor and a report typist, have been hired for the term of the Agreement. In 1986, the staff of this section edited and prepared for publication 11 reports and approximately 200 maps. The following is a list of these reports:

In 1986 the following reports, produced under the MDA, have been edited by the Geoscience Editor's Section with assistance from other staff members:

Open File Report 86-4	Granular aggregate resources of the Kedgwick - Saint-Quentin - Grand River area (NTS 21 N/16, 21 O/5, 11, 12, 13, 14), northwestern New Brunswick - A.J. Cooper (Gartner Lee Associates Limited) in conjunction with Three-D Geoconsultants Limited. 138 p., 6 maps (1986).
Open File Report 86-5	Granular aggregate resources of Big Bald Mountain (NTS 21 O/1), Serpentine Lake (NTS 21 O/2), and California Lake (NTS 21 O/8), New Brunswick - S. Paradis, R.D. Thomas, V.N. Rampton (Terrain Analysis and Mapping Services Ltd.). 131 p., 5 maps (1986)
Open File Report 86-7	Oil shale assessment of the Albert Formation in the Rosevale area of Albert County, New Brunswick. - D.F. Brown and K.D.A. Whaley. 135 p., 27 maps (1986)

The following reports, produced by Mineral Resources Division staff, were edited and published in 1986:

PM 86-216 Till geochemistry of Tetagouche Lakes map area (21 O/9), New Brunswick.

A.G. Pronk
11 p., 1 map

MR 86-1 Geology of Sisson Branch Reservoir map area (NTS 21 O/6), New Brunswick.

R.R. Irrinki and G. Crouse
19 p., 1 map

MR 86-2 Geology of Big Bald Mountain map area (21 O/1), New Brunswick.

R.R. Irrinki
61 p., 5 maps

OF 86-1 Granular aggregate resources of the Central Lowland area, East-central New Brunswick.

A.A. Seaman and J.J. Thibault
231 p., 15 maps

OF 86-2 Mineral production statistics, 1956-1984, New Brunswick.

J.J. Chandra
105 p.

OF 86-3 New Brunswick mineral-based commodities for the manufacturing sector.

J.J. Chandra
65 p.

OF 86-11 Symbols, abbreviations, and procedures for New Brunswick standard lithologic well log.

C. St. Peter
24 p.

OF 86-12 Granular aggregate resources of southeastern New Brunswick.

A.A. Seaman
84 p., 5 maps

The maps produced by the Mineral Resources Division in 1986 were also edited by the Geoscience Editor's Section. The number to date is 221, including those that accompany reports.

MINERAL EXPLORATION ASSESSMENT REPORTS

Since the beginning of the year, 69 assessment reports have been filed with the Mineral Lands Section. These reports have been indexed and included in the GSC's bibliographic data base called GEOSCAN. An index to the 1985-86 assessment reports will be produced for handing out at this year's Review of Activities.

The Geoscience Data Centre is continuing to microfilm all incoming assessment reports and placing duplicate microfiche copies in our two regional offices and in several public libraries across the province.

Because of the new Mining Act (M-14.1) and revised regulations under that Act, the Mineral Lands Section will receive much larger volumes of assessment data which will have to be properly stored and secured before release to the public.

GEOSCIENTIFIC PUBLICATIONS

The publication section of the Geoscience Data Centre plays an important role in the dissemination of geoscientific data produced by or for the Mineral Resources Division. Since the beginning of the year, 18 reports and 221 maps have been added to our list of publications. For the period January-September 1986, publication sales totalled approximately $ 18,993.64. Total distribution of all documents was 4,884.

In 1986, the Geoscience Data Centre was involved in seven public releases of geochemical and/or geophysical results from surveys conducted by the Geological Survey of Canada (GSC) under the MDA or the Department of Natural Resources and Energy. These included:

GSC April 29, 1986 Airborne Gamma Ray Spectrometric, VLF and Magnetic Survey, Miramichi Highlands.

GSC May 28, 1986 Airborne Gamma Ray Spectrometric, VLF and Magnetic Survey, St. George-Saint John Region.

DNRE May 28, 1986 Surficial Geology and Till Geochemistry of Goose Creek.

DNRE June 17, 1986 Stream Sediment Geochemical Survey, Northern New Brunswick.

GSC July 2, 1986 Regional Stream Sediment & Water Geochemical Reconnaissance Data, Northern New Brunswick.

DNRE July 8, 1986 Re-Analyzation of Stream Sediment Samples (21 O/11, 21 O/6, 21 O/8).

DNRE September 23, 1986 Till Geochemistry of Tetagouche Lakes Map Area (21 O/9).

PUBLIC AWARENESS

Several displays and publications were produced in 1986 by the Geoscience Data Centre in order to increase the public's awareness of Division activities, the mineral industry, and related MDA projects.

Displays:

At the 54th Annual Meeting of the Prospectors and Developers Association in Toronto, the Geological Surveys Branch exhibited a display summarizing gold exploration activities and occurrences in New Brunswick. Senior staff from Bathurst and Sussex were on hand at the display to answer people's inquiries.

In addition, the MDA display that was produced last year was updated to reflect the 1986 MDA projects of the Geological Survey of Canada and the Mineral Resources Division. This display was also taken to the Prospectors and Developers meeting in Toronto.

Before fiscal year-end (March 1986), it is anticipated that three additional displays will be produced: (1) a potash display for the general public, (2) a geological exhibit for the 1987 Prospectors and Developers in Toronto, and (3) a general display outlining New Brunswick's mineral industry designed for the 1986 Review of Activities and the CIM District I Convention in Halifax in November.

Prospecting Courses:

One of the projects carried out under the MDA in 1986 was the Advanced Prospecting Course held in September. A total of 15 students attended the course in Newcastle, which for the first time was conducted in a one-week session. The chief instructor was Mr. A.W. Lockhart, consulting geologist. Practical field applications were the emphasis of this course which also included such topics as orienteering, claim staking, grid line cutting, geochemical sampling, geophysical surveying, assessment work reports, and mineral deposit types.

Publications:

In response to the mandate of the Public Information and Awareness Sub-Committee of the MDA, four information brochures are scheduled for completion by year-end. These publications are being produced by the staff of the New Brunswick Department of Natural Resources and Energy, Mineral Resources Division and the Communications Section; the Geological Survey of Canada; and Canmet, Mineral Policy Sector, and Communications Branch of Energy, Mines and Resources Canada.

The first brochure to be produced was a document that outlined the objectives and details of the Mineral Investigations Stimulation Program (MISP), a program funded by the Economic Development Program of the MDA. Project manager for this program is Mr. D. Thibault of the Mineral Development Branch of the New Brunswick Department of Natural Resources and Energy.

Two additional MDA-sponsored publication projects included the first issue of a Canada-New Brunswick Mineral Development Agreement Newsletter and the first MDA annual report.

A publication totally sponsored by the Department of Natural Resources and Energy was a brochure that outlined the rights and obligations of a person possessing a prospecting licence and the rights of a landowner upon whose property a prospector may traverse and possibly stake mineral claims. Because of new regulations under the Mining Act, a document was required to explain the aforementioned subject of rights and thus hopefully avert possible confrontation between landowners and prospectors.

AUDIOVISUAL PRODUCTIONS, PRESENTATIONS

Audiovisual media (film, video, or photographic prints) are an important part of the Public Awareness Program under the MDA and the Division's own information awareness activities.

During the past nine months, the Geoscience Data Centre has been involved in the production of audiovisual programs and in updating the photographic files of the Division.

To supplement the existing film entitled "The Awakening Giant", depicting the mineral resource industry of New Brunswick in 1979-80, a new film is being produced. The new film will portray the mineral industry with respect to New Brunswick mineral products and related technological research. The pre-production filming phase of the project began this summer, utilizing the services of Fiddlehead Film Productions Limited. Aerial film footage of all major mining operations has been taken in addition to ground follow-up footage of plant sites, production methods, and end products. This production, which is to be released in video format, should be completed by fiscal year-end 1987-88.

A video production by the Atlantic Geoscience Society, is being funded under the Federal portion of the Canada-Nova Scotia and Canada-New Brunswick Mineral Development Agreements. The title of this video is "The Mineral Wealth of Atlantic Canada" and it is being produced by Skerrett Communications Limited for Energy, Mines and Resources Canada, Communications Branch.

The Communications Branch of Energy, Mines and Resources is conducting an MDA-sponsored project to update the Division's photographic files (aerial) with respect to New Brunswick mining properties. This project is scheduled for completion by December 1986. Images resulting from this project will be used both by Energy, Mines and Resources and the Mineral Resources Division in their public awareness and information programs and publications.

OTHER

Besides producing and distributing literature for the Mineral Resources Division, the Geoscience Data Centre provides educators with information on New Brunswick's geology and mineral resources as well as maps and rock kits.

Staff of the Geoscience Data Centre give oral presentations at schools, organizational meetings, and conferences. One such presentation was given by D.J.J. Carroll at the 1986 CIM New Brunswick Mini-Convention in Bathurst. The topic was "The New Brunswick Department of Natural Resources And Energy, Mineral Resources Division, A Review of Programs and Services."

The Geoscience Data Centre played host to an employee from the Department of Mineral Resources of the Royal Thai Government, who was on a fact-finding tour of several provincial agencies responsible for distribution of geoscientific information.

MINERAL DEVELOPMENT BRANCH

CARBONIFEROUS LIMESTONE RESOURCES OF NEW BRUNSWICK

T.C. Webb, Industrial Minerals Geologist

INTRODUCTION

Most of New Brunswick's main resource-based industries are dependent to some degree on a reliable, nearby supply of limestone, dolomite, or their products. Although traditionally used as a soil conditioner in agricultural practices and as a source of aggregate, it is apparent that over the last 10 or 15 years, limestone, in the form of lime, has become an essential chemical with a formidable list of uses. Indeed, limestone is probably one of the most useful and versatile of all the industrial mineral commodities produced in this province.

Although rocks classified as limestone are relatively plentiful throughout much of New Brunswick, the supply of certain grades of stone, such as high-grade calcium limestone, is surprisingly limited. With physical and chemical specifications for limestone becoming more stringent, and with expanding applications of limestone particularly in the fields of environmental clean-up, effective evaluation and prudent management decisions affecting the Province's limestone resources are becoming increasingly important.

Since the publication of J.B. Hamilton's "Limestone in New Brunswick" in 1965, there has been no concerted effort to update information on our provincial limestone resources with the exception of some information in Mineral Resources Division files and reports and in company assessment files.

Over the last 20 years, there have been a number of significant developments concerning the Province's limestone industry - the expansion of Havelock Lime Works Ltd. into the field of quick and hydrated lime, and the reopening of a quarry at Elmtree in northern New Brunswick, for example. Various exploration programs for limestone have been undertaken both by government and private industry resulting in new occurrences being discovered as well as adding to a plethora of information concerning the evaluation of known deposits.

Although limestones are represented to some extent in virtually every geologic system in New Brunswick, it is only in Carboniferous, Silurian, Precambrian, and possibly Ordovician strata that they attain sufficient thicknesses and grades to be considered deposits of some economic significance.

Notable deposits of Carboniferous limestones are mainly restricted to Mississippian age rocks belonging to the Windsor Group and Plaster Rock Formation.

Windsor limestones are found primarily in the south eastern portion of the province (Figure 22) extending from the Sussex area northeast to Hillsborough, along the exposed, marginal, and up-faulted parts of the Moncton and Cumberland subbasins. Other Windsor deposits sporadically outcrop along the southern flank of the Marysville subbasin in Queens County, 40 km south of Fredericton.

Limestones of the Plaster Rock Formation form a relatively isolated deposit situated in the Plaster Rock subbasin of Victoria County, in the northwestern part of the province.

PURPOSE AND SCOPE

The objective of this limestone investigation is to present contemporary and relevant information with respect to significant deposits of limestone and dolomite occurring in Carboniferous rocks throughout New Brunswick. The information is not only intended to assist in the assessment of our more well known deposits, but will provide a starting point for individuals or companies considering exploration and possible future development of specific limestone deposits.

Included in this study is information from both published and unpublished sources that has been accumulating in the Mineral Resources Division files over the last two decades.

Pertinent data on access, topographic, and geologic settings (stratigraphy and structure), and any related exploration or development involving specific deposits are recorded where possible. Even though preliminary observations concerning grades, tonnages, and quarry opportunities are offered for most deposits, it is important to note that observations are based on broad generalizations, and in some cases, cannot at this time be considered as completely reliable without further, more detailed evaluation.

Field investigations of Carboniferous limestones were initiated during the spring of 1983 and were completed, more or less, by the fall of 1984. This work was directed toward extensive sampling and surface mapping covering several major Mississippian limestone belts and outcrop areas distributed throughout Kings, Albert, Westmorland, Victoria, and Queens counties. Several smaller local deposits scattered along the Bay of Fundy in Saint John County were also examined.

Representative samples from most deposits have been catalogued and are stored in an easily accessible manner at either the Fredericton or Sussex regional offices of the Mineral Resources Division. Existing sample analyses from past

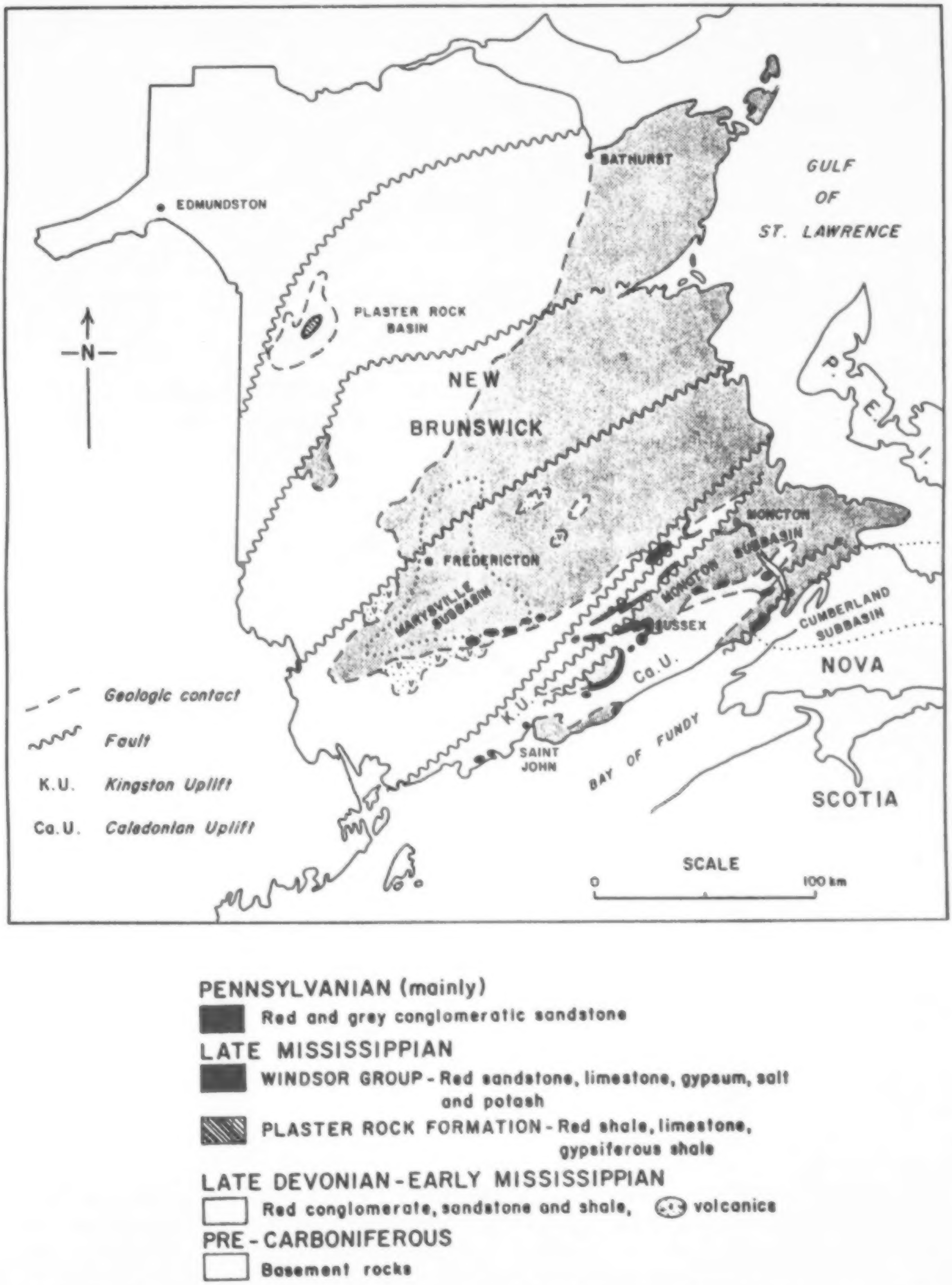


Figure 22. Distribution of Carboniferous limestone in New Brunswick

investigations were compiled and samples collected during the current study were selectively analysed from areas where the quality of stone and the opportunities for potential quarry development appeared to be favourable following a preliminary inspection. Both sample information (i.e., location, description, available analysis, etc.) and relevant drill-hole data for most areas have been compiled on the Division's computer system for quick and easy reference.

Detailed descriptions concerning individual Windsor Group and Plaster Rock Formation limestone occurrences and associated outcrop belts are provided to acquaint the reader with the various aspects of each deposit being investigated. Some of the more significant limestone outcrop belts discussed have been mapped at a scale of 1:10 000 (Figure 23).

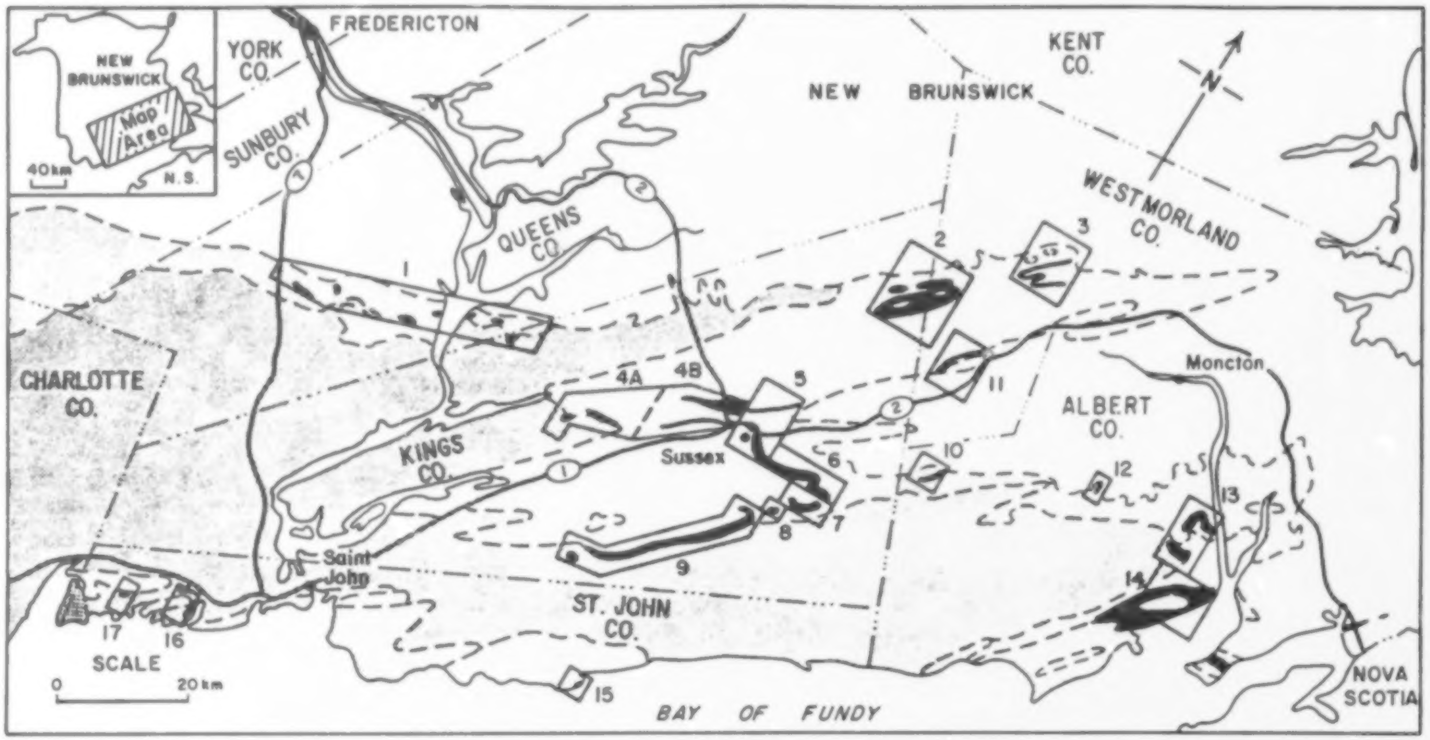
WINDSOR GROUP LIMESTONES

The limestones of the Windsor Group are unique in that they form an intregal part of a sequence of rocks representing a period of widespread, shallow marine flooding and subsequent evaporation of this sea water, which occurred throughout a substantial portion of southern New Brunswick, over 350 million years ago. Most of the more significant limestone deposits occur in narrow, northeast-trending, sinuous outcrop belts, preserved along the flanks of regional synclinal structures contained in two large sedimentary basins, namely the Moncton and Cumberland subbasins. Other scattered outcrops occur south of Fredericton along the southern margin of the Marysville subbasin and a few isolated occurrences are found in several small fault blocks near Saint John.

In general, Windsor limestones seldom exceed thicknesses of 30 m and generally dip at angles ranging from 15° to 45°. CaO grades often vary between 45 and 55% and MgO contents exceeding 2% are the exception rather than the rule. The most significant concentration of outcrops is found in Kings County.

Throughout southern New Brunswick, Windsor limestones have been divided into three recognizable lithofacies. These are considered to be laterally equivalent in part, and include the Gays River, Parleeville, and Macumber formations. Figure 24 summarizes the lithology, quality, potential recoverable reserves, and maximum observed thickness of limestone associated with each formation.

During the course of this investigation, it was generally recognized that Gays River rocks exhibit the most favourable development potential of all the main Windsor limestone-bearing formations, from both grade and a recoverable reserves view-



▱ MAP AREAS (for PLATES see MAP APPENDIX / for FIGS. see text)

1. Carpenter-Shannon-C.F.B. Gagetown (Plate 86-239)
2. Havelock (Plate 86-240)
3. Nevers Brook (Fig.)
4A. Case Syncline (West Half) (Plate 86-234)
4B. Case Syncline (East Half) (Plate 86-235)
5. Smith Creek Anticline (Plate 86-233)
6. Sussex Corner-Urney-Cedar Camp (Plate 86-232)
7. Waterford Syncline (Plate 86-238)
8. Glebe Syncline (Plate 86-237)
9. Marchbank Syncline (Plate 86-236)
10. Elgin (Fig.)
11. Interval-Hillgrove (Fig.)
12. Berryton (Fig.)
13. Hillsborough-Albert Mines (Plate 86-231)
14. Shepody (Fig.)
15. Quaco Head (Fig.)
16. South Musquash (Fig.)
17. Haleys Cove (Pork Ledge) (Fig.)

△ POST-CARBONIFEROUS
△ PENNSYLVANIAN
△ MISSISSIPPIAN
▲ PRE-CARBONIFEROUS

Figure 23. Location map showing distribution of Windsor Group outcrop (black) and areas mapped

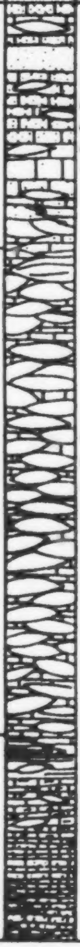
FORMATION (WINDSOR GP.)		LITHOLOGY	AVG. CaO % GRADE GRADE CONTINUITY	RECOVERABLE RESERVES	OBSERVED THICKNESS (metres)
PARLEEVILLE		*Minor algal mounds, intercalated with calcareous sandstone and arenaceous limestone*	Usually < 51.0 Poor	Very limited	1 - 22
GAYS RIVER		*Irregular-bedded (stacked) algal mounds with intercalated, allochthonous limestone*	Usually ≥ 52.0 Good	Most deposits < 1.0 million tonnes with some exceptions (ie Havelock, Glebe Mine)	2 - 80
MACUMBER		*Thin-bedded, argillaceous to arenaceous, allochthonous limestone*	Usually < 52.0 Good	Limited	2 - 18

Figure 24. Summary of Windsor Group, limestone-bearing formations

point. These thick, irregular-bedded, algal carbonate build-ups, which generally maintain CaO values ranging between 53 and 54%, are commonly found resting on or near intrabasinal basement highs. These areas, being somewhat elevated above the sediment-laden bottom waters of the nearshore environment and the hypersaline brines collecting in the deeper water environment (Figure 25), provided a very favourable niche for a flourishing algal community, which became a very important agent, organically concentrating $CaCO_3$.

Not only were such elevated areas free of terrigenous contamination; they also played an important role in the diagenetic history of the limestone deposits. A significant primary porosity probably developed within the algal masses due to the rather rapid decay of mound material during the initial stages of deposition. Upon subaerial exposure, porosity probably acted as a very effective plumbing system, allowing undersaturated $CaCO_3$ solutions to circulate throughout the existing limestone, redissolving and modifying the existing porosity at some locations and reprecipitating $CaCO_3$ at other locations (recrystallization). Evidence of this recrystallization process is well represented in Gays River rocks and has resulted in a number of favourable physical properties, such as large crystal sizes and a well-developed secondary porosity which significantly enhance the calcining properties of crushed limestone in the production of lime.

One additional characteristic of Gays River rocks is that apparent thicknesses can change rapidly, sometimes within a few tens of metres. This is believed to be due to unexpected irregularities in the basement topography. Considerable care must, therefore, be undertaken when evaluating properties underlain by Gays River strata. Such an evaluation would no doubt require a number of closely spaced drill holes.

Although the Parleeville Formation also locally contains high-calcium algal build-ups, they are not nearly as extensive as their Gays River counterparts and are characteristically intermixed with a significant proportion of siliciclastics. These rocks, considered to be a nearshore equivalent of Gays River strata, are typified by both rapid vertical and lateral facies variations (Figure 25). With few exceptions, the formation generally lacks sufficient grade continuity and thickness to be considered as an important source of limestone. Recoverable reserves from even some of the more favourable quarry sites are estimated to be quite limited.

The thin, even-bedded limestones of the Macumber Formation are interpreted as the down-dip, basinward accumulation of the erosional remnants of both the Parleeville and Gays River strata (Figure 25). Even though these rocks contain high-calcium, siliciclastic, and argillaceous material, the overall grade, ranging between 51 to 52% CaO, which is lower than that of Gays River rocks, is surprisingly uniform. Despite this grade consistency, most occurrences are characterized by steep dips and lack sufficient thickness, severely limiting recoverable reserves in most cases.

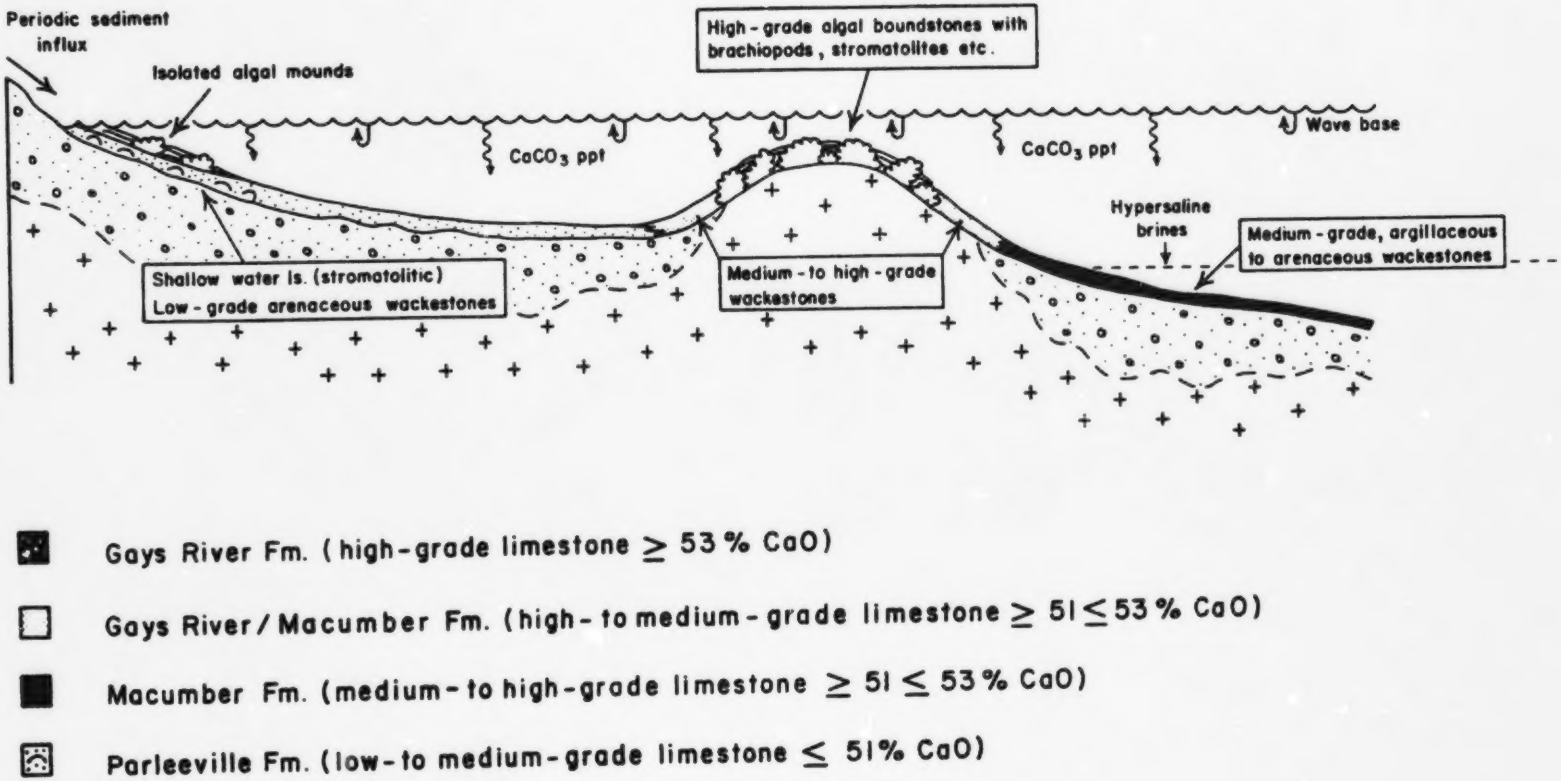

Periodic sediment influx
Isolated algal mounds
High-grade algal boundstones with brachiopods, stromatolites etc.
CaCO$_3$ ppt
CaCO$_3$ ppt
Wave base
Hypersaline brines
Medium-grade, argillaceous to arenaceous wackestones
Shallow water ls. (stromatolitic) Low-grade arenaceous wackestones
Medium-to high-grade wackestones
Gays River Fm. (high-grade limestone $\geq$ 53 % CaO)
Gays River/Macumber Fm. (high- to medium-grade limestone $\geq 51 \leq 53$ % CaO)
Macumber Fm. (medium-to high-grade limestone $\geq 51 \leq 53$ % CaO)
Parleeville Fm. (low-to medium-grade limestone $\leq$ 51% CaO)

Figure 25. Windsor limestone facies and grade distribution during the transgressive carbonate depositional stage

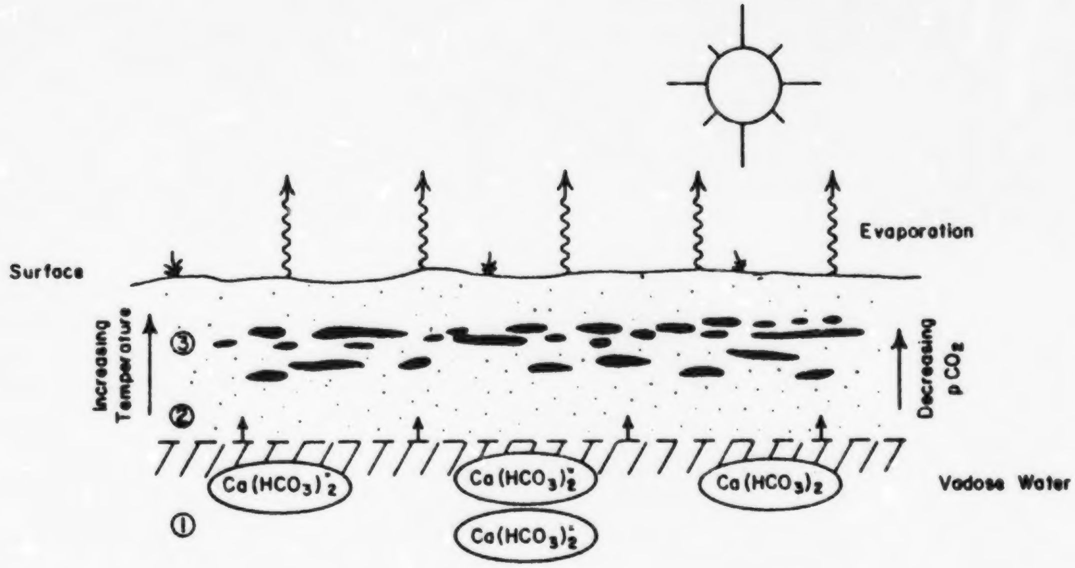
PLASTER ROCK FORMATION

The Mississippian Plaster Rock Formation underlies an elliptical-shaped area of about 100 km^2 near the structural centre of the Plaster Rock subbasin in Victoria County (St. Peter 1979). Comprising an overall thickness of 150 to 300 m (St. Peter 1979), the formation consists of a lower, caliche-type nodular limestone/shale member and an upper member of diagenetic, nodular gypsum/shale. The lower member is the most voluminous and comprises a bulk of the formation's estimated thickness.

Caliche deposits are generally the product of secondary processes affecting soils in semi-arid climates. Extensive evaporation in such an environment causes an upward movement of calcium bicarbonate ($Ca(HCO_3)_2$) "soil water" (vadose water) by capillary action. As this water moves toward the surface, it is gradually warmed and the partial pressure of CO_2 (carbon dioxide) decreases significantly. Under these conditions, the mobile, calcium bicarbonate solution becomes unstable and dissociates into water (H_2O), carbon dioxide (CO_2), and calcium carbonate ($CaCO_3$). The excess water is evaporated, the CO_2 evolves as a gas, and the $CaCO_3$ is left behind forming nodules and irregular beds of limestone (Figure 26).

Plaster Rock limestones are typically white to greenish grey in colour, varying in bedding style from a predominantly nodular habit to a more massive variety up to 3 m thick. Nodular beds consist of irregular limestone lenses and nodules intermixed with irregular patches of red and grey shale.

Most limestones offer, at best, very limited development potential. The stone is generally impure, rarely exceeding 50% CaO and averaging 45% CaO. The presence of variable amounts of interbedded and disseminated red shale, which must be quarried in conjunction with limestone, in most cases, could be expected to lower these grades significantly. Zones where limestone is the dominant lithology are generally thin (less than 3 m) and have an irregular, patchy distribution along strike. Even though a few Plaster Rock deposits are probably of sufficient grade to meet local agricultural needs, recoverable tonnages are anticipated to be extremely limited. In addition, large-scale quarry development in these areas would be an expensive, if not an impossible undertaking, due to variable overburden thicknesses and the close proximity of most potential sites to major waterways.



① Soluble calcium bicarbonate ($Ca(HCO_3)_2^{=}$) in vadose ground water.

② Evaporation causes upward movement of water through soil by capillary action.

③ Lower CO_2 pressure and increasing temperature results in the dissociation of $Ca(HCO_3)_2^{=}$ into water (H_2O), carbon dioxide gas (CO_2) and limestone ($CaCO_3$).

$$Ca(HCO_3)_2^{=} \rightleftharpoons \overset{\uparrow}{H_2O} \cdot \overset{\uparrow}{CO_2} \cdot \underset{\downarrow}{CaCO_3}$$

Figure 26. Explanation for the formation of caliche-type limestone deposits, Plaster Rock Formation, Victoria County, New Brunswick

MINE ENGINEERING

J.J. Chandra, Mining Engineer

INDUSTRY STUDY

A report on the New Brunswick mining industry was jointly prepared by Employment and Immigration Canada; the New Brunswick Department of Labour; and the Department of Natural Resources and Energy. The report reviews the history of mining activity in the province and highlights the contribution to the economy of the several segments of the industry.

The purpose of the report is to provide a comprehensive examination of the economic and occupational outlook for the mining industry in New Brunswick over the next 10 years. Attention is directed especially to how changing international demand for minerals, technological advancement, and substitute materials are affecting the Province's mining industry, both in terms of economic performance and employment. The industry is undergoing retrenchment, the result of the aftermath left by the 1981-1982 recession, increasing competition from foreign producers and continued depressed mineral prices. This retrenchment is contributing to layoffs and reduced employment through attrition.

The industry, however, continues to play a vital role in the Province's economic growth and development. This role is expected to become even more pronounced in the next decade resulting from increased demand for both metals and nonmetals.

PRODUCTION STATISTICS

Mineral production data for the period 1899-1985 has been prepared as Open File Report No. 86-2. This document contains listings of annual production figures for metals, nonmetals, fuels and structural materials. Included are graphic plots for each commodity. Value statistics ($) are provided in both current and constant Canadian dollars.

A REPORT ON MINERAL-BASED MANUFACTURING OPPORTUNITIES IN N.B.

The decline in the growth rate of world mineral consumption is creating major problems for the mineral industry. Downsizing, environmental protection, energy conservation, substitution, alternative supply sources, foreign competition, increased production, and capital costs are some of the major factors contributing to this decline. Mineral-based economies cannot continue to rely on the export of raw materials, in the form of concentrates and ores, as the primary source of revenue.

New Brunswick produces large quantities of copper, lead, zinc, silver, bismuth, antimony, sulphur, and potash, in addition to smaller quantities of gold, peat, and coal. It also has major potential to produce molybdenum, tungsten, tin, oil shales, manganese, and various industrial minerals. All of these commodities, and those yet to be exploited, can be used in downstream manufacturing of mineral-based commodities. The loss of job opportunities in mining can be compensated by new positions created in mineral-based manufacturing. Downstream manufacturing also provides "value added" and may be sufficient to offset losses in income and mining taxes.

The following topics have been covered in this report: (1) Identification of the metals, minerals, and rocks currently produced in N.B. and those with potential for production. (2) Identification of the basic saleable forms of each mineral commodity. (3) Outline of the various uses for each form with their approximate percentage, re: market penetration. (4) Outline of possible mineral-based manufacturing opportunities for the various forms of the basic metallic and nonmetallic mineral resources produced in New Brunswick.

REACTIVE ACID TAILINGS PROGRAM (RATS)

Many mines in Canada will close within the coming decade. This is not only because of poor metal prices, but because many mines will have been depleted. To allow "walk-away" by mining companies, tailings around these sites have to be reclaimed.

The Reactive Acid Tailings Program (RATS) is a joint Federal-Provincial-Industry effort served by a board (steering committee) to review and approve projects and a technical committee (technical working group) to prepare project details, resource requirement and scheduling. The objectives of the program are "to provide a comprehensive scientific, technical and economic knowledge base so that the mining industry and governmental agencies can predict with confidence the long-term management requirements for mine and mill tailings and to establish techniques that will enable the operation and abandonment of acid-generating tailings disposal areas in a predictable, affordable, timely and environmentally acceptable manner."

The RATS groups are as follows:

Steering Committee

MSL Director
MRL Director
Participating Mines
Provinces
Environment Canada

Steering Committee Executive

Industry - F. Frantisak, V.P. Noranda
Provincial - J.R. Hawley, Ontario Env.
CANMET - E. Joe (Secretary)

Technical Working Group

Steering Committee Executive Secretary

CANMET	Project Leader
Noranda	Project Leader
INCO	Project Leader
Falconbridge	Project Leader
COMINCO	Project Leader
Manitoba	Project Leader

The Department of Natural Resources and Energy has one representative in the Steering Committee.

Some of the tasks to be undertaken by RATS are as follows:

(i) Examine all tailings sites and prepare a comprehensive document on the state of these tailings and the present methods used in their rehabilitation.

(ii) Prepare a review document of all new methodologies applied to tailings both in Canada and overseas.

(iii) Recommend appropriate studies to evaluate new techniques by both laboratory and field experiments.

(iv) Determine best methods applicable to tailings sites in Canada and prepare procedural manuals for dealing with specific types of tailings.

(v) Prepare an Annual Report to inform all parties concerned about the RATS program and its activities. This will be supplemented by newsletters.

The RATS program is expected to last from 5 to 10 years. Financing of the program will be through CANMET, Provincial Governments, and participating mines.

Projects approved by the Steering Committee for fiscal year 1986-1987 are as follows:

Project	Total Cost	CANMET Cost
Noranda - Hydrogeochemical investigation of Waite Anulet reactive tailings	225 K	110 K

Falconbridge - Developing a technique for reclamation of high-iron sulphur tailings by establishing a marshland	61.7 K	35 K
Cominco - Reclamation of pyrrhotite tailings with float and gypsum	40 K	20 K

SPONSORED ENGINEERING STUDIES

Two studies have been sponsored at UNB to allow students to research subjects related to the mining industry and which could be used as course or thesis material. They would also be of value to the Mineral Resources Division.

(1) Assessment of Digital Enhancement techniques using TM Data in the mapping of lineaments, with application to the Mactaquac Headpond area, southern New Brunswick.

Student: G. Goucher (Geological Engineering, UNB)
Supervisors: R. Yazdani, J.J. Chandra, E. Derenyi

The objective of the study is the investigation of the use of digital enhancement techniques in the mapping of lineaments (structures) in the region which may be causing rock creep and local uplift.

(2) Digital enhancement of Landsat MSS data with application to the Brunswick Mines area.

Student: M.J. Carr
Supervisors: R. Yazdani, J.J. Chandra, E. Derenyi

Objectives of the study area are as follows: (1) to identify tonal patterns that can be ascribed to stress on the environment (2) to separate stressed areas into two classes, natural and man-induced (3) to correlate naturally stressed areas with exploration geochemistry data and evaluate this technique as a possible exploration tool (4) to correlate man-induced stressed areas with tailings piles, ponds, road network, etc. and to describe the effectiveness of this method as an environmental monitoring tool (5) to map all linears and curvilinears identifiable from the processed images, correlate this data with known geology, and differentiate between mapped and image-processed linears.

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YAZDANI, R., DERENY, E., CHANDRA, J.J. and GOUCHER, G. 1986. Assessment of digital enhancement techniques using TM data in the mapping of lineaments, with application to the Mactaquac Headpond area. Paper presented at International Symposium on Remote Sensing of the Environment. 5th Thematic Conference on Remote Sensing for Exploration Geology. Sept. 29 - Oct. 3, 1986. Reno, Nevada, U.S.A.

IMAGE ENHANCEMENT TECHNIQUES APPLIED TO REMOTELY SENSED MULTISPECTRAL SCANNER (MSS) DATA OF THE BRUNSWICK MINES AREA (APPLICATIONS IN GEOLOGY)

Jeff Carr

The report investigates the use of satellite imagery in the identification of tonal patterns that can be ascribed to stress on the environment. Also it examines the delineation of linear features that may be related to stratigraphy and mineral deposition. Information gathered by a multispectral scanner located aboard a Landsat satellite is digitally enhanced to facilitate ease of interpretation. Enhancement includes linear stretches, high and low pass filtering, manually specified directional filtering, band ratioing, and sun illumination.

These techniques were applied to data gathered from the Brunswick mines area, New Brunswick. Several sites of geological and environmental interest are identified with the information made available through satellite imagery enhancement.

MINERAL DEVELOPMENT - PROCESS STUDIES

D. Thibault, Process Engineer

The activities of process studies within the Mineral Development Branch include administrative roles under the Mining Act and the development of metal extraction technology within New Brunswick. Development defined as the engineering activity required to advance the design of a metal extraction process to the point where it meets specific functional and economic requirements, which also includes the technical activity concerned with problems associated in transforming ore reserves into commercial products. In recognition of problems within the mining sector of New Brunswick being associated with "grass roots development" the following programs were initiated under the July 11, 1986 amendment of the Federal-Provincial MDA.

MINERAL PROCESSING INVESTIGATIONS PROGRAM (MPIP)

Various projects are being carried out by the Mineral Development Branch using bench-scale testing methods to initialize development in extraction technologies and optimization of grade-recovery relationships. Various orebodies and extraction processes are being reviewed on provincial ores containing precious metals, speciality metals used in high tech industries, base metal complex sulfides, tungsten, molybdenum, tin, and industrial minerals.

MINERAL INVESTMENT STIMULATION PROGRAM (MISP)

MISP is a direct private sector assistance program in which fifty per cent of approved projects is funded by the Economic Development Program of the MDA under the administration of the Mineral Development Branch. Eligible projects include investigations in the areas of primary processing (communition and beneficiation), productivity studies, and market studies to achieve primary development of the province's mineral resources and enhance the viability of existing resources.

The objective in administering these programs is to provide a financial and technical support to industry in primary development of New Brunswick mineral resources and assist in optimization of metal recoveries.

OIL SHALE INVESTIGATIONS

Clint St. Peter, Energy Geologist

Pilot scale oil shale retorting and oil shale and coal cocombustion testing at the Research and Productivity Council in the first part of this decade have demonstrated the viability of retorting New Brunswick oil shale or cocombusting it with New Brunswick sulphur-bearing coal. An outcome of the New Brunswick Research and Productivity Council (RPC) test work has been the construction of an oil shale and coal circulating fluidized bed demonstration plant in Chatham. The combustor will fire a 22 Megawatt generator. In the event that large quantities of oil shale may be required in the future to supply this or other combustors, the Mineral Development Branch of the Department of Natural Resources and Energy decided in 1985 to undertake a detailed resource evaluation of known oil shale beds in the Rosevale area of Albert County (Figure 27).

Under the federal-provincial MDA, this resource evaluation was carried out for the Branch by K.D.A. Whaley of Fredericton under a provincial contract. Whaley successfully drilled six (6) holes totalling 908 m of NQ core. The core was lithologically logged in detail and 505 samples encompassing 300 m were subjected to organic geochemical and carbonate analyses. Caliper, resistivity, gamma-gamma, density, and porosity logs were run on each hole. The drilling and analytical results indicate that a high-grade oil shale zone is exposed at the surface and contains, to a depth of 100 m, about 4.4 million tonnes of shale yielding 100 litres/tonne of shale oil. The exploitable zone averages 15 m in thickness and is exposed over a strike length of 900 m. The same zone contains 27 per cent dolomite (or dolomite equivalent) which is a more than adequate amount of carbonate to capture all sulphur oxide gases generated by the cocombustion of the shale with New Brunswick coal.

The recent Rosevale oil shale assessment has reconfirmed previous field investigations: specifically that organic-lean and organic-rich oil shale beds are closely interstratified and therefore the prospects of "high grading" large quantities of oil shale are quite remote. Consequently, the Branch has initiated research into methods of upgrading or beneficiating the Albert Formation oil shales. It is desirable to utilize the organically lean and carbonate-rich shale as a sulphur-capturing medium when cocombusted with coal. The organically rich shale, on the other hand, is more profitably retorted for shale oil recovery. Thereafter those retorted shales can be recycled to a combustor for carbonate mineral and carbon residue utilization.

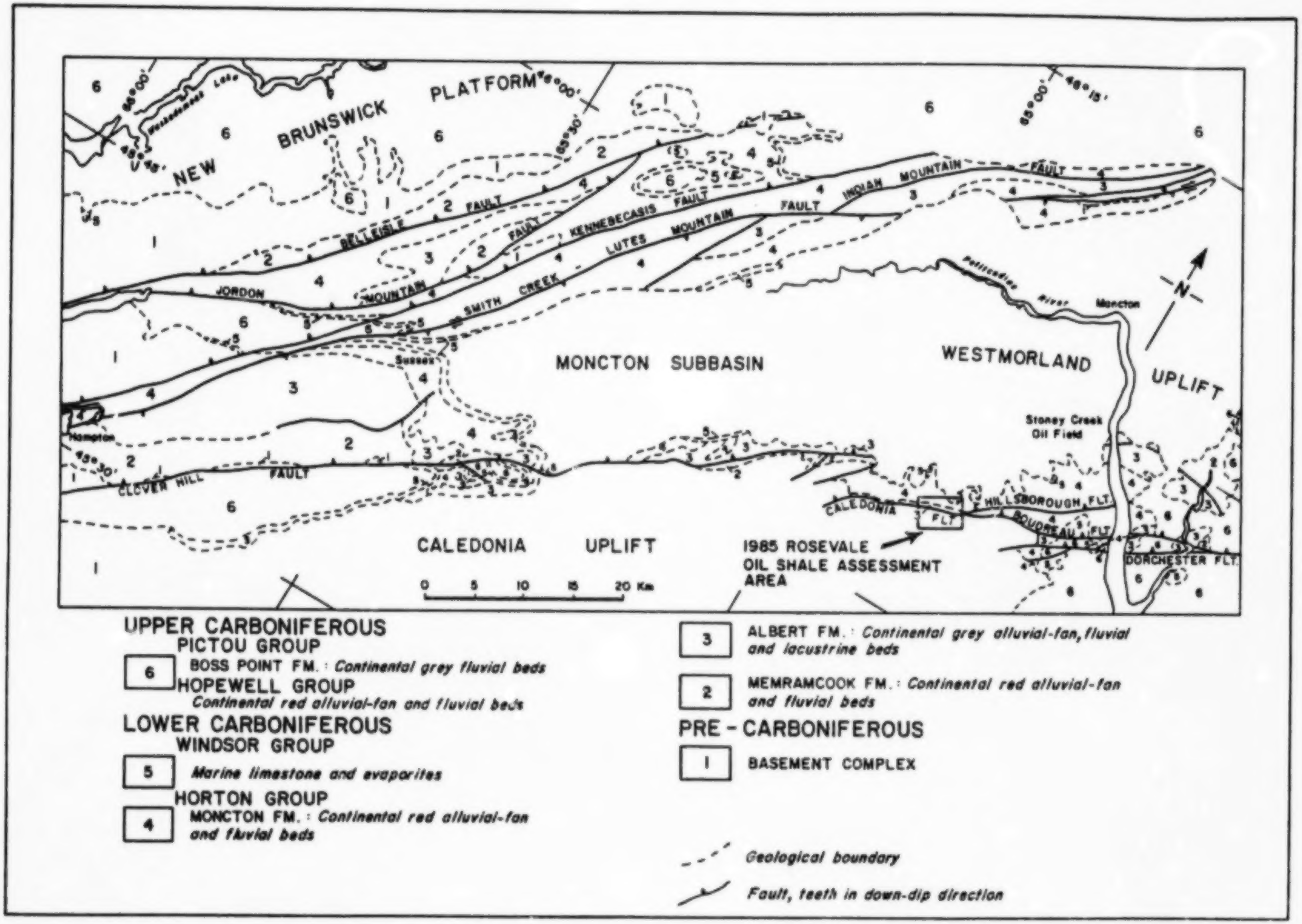

Figure 27. Simplified geology of Moncton Subbasin

Two bulk samples for the beneficiation study have recently been acquired from the Albert Mines area about 25 km south of Moncton (Figure 27). Bench scale size analysis, gravity analysis, and a spectrum of beneficiation techniques will be carried out on the samples during the next year.

DIAGENESIS OF THE ALBERT FORMATION

A.H. Chowdhury

Oil and gas exploration in the terrestrial sediments of the Lower Carboniferous Albert Formation in the Moncton Subbasin dates back to 1849. Although many holes have been spudded, the nature and distribution of reservoir sandstone bodies have not been adequately investigated.

In order to better understand the reservoir characteristics, and therefore the oil and natural gas potential of the Albert Formation, a diagenesis study has commenced. Diagenesis is the chemical and physical change that sediments undergo during and after their accumulation. The changes may be due to bacterial action, digestive processes of organisms, solution and redisposition by permeating water, or replacement.

Samples for this study have been collected from the Stoney Creek oil and gas field, Lower Millstream, and the Dover-Boudreau area. Wells were selected on the basis of maximum depth and the presence of reservoir horizons. Wells were chosen with a wide distribution to gain a broad regional understanding of the sedimentary facies relationships.

Over the summer of 1986, several outcrop sections in the Moncton Subbasin were studied and sampled. This was carried out to document weathering processing at the exposure surface. Sampling of surface and subsurface sections was conducted in order to identify various lithofacies.

Thin-section studies, employing optical microscopy, were used to establish the authigenic components, porosity, and textural relationship of detrital minerals. The scanning electron microscope accompanied by energy dispersive X-ray was used primarily to identify clay-mineral type and morphology, and the nature of cement-porosity relationships.

Further research will involve thermal maturation study of organic matter, homogenization temperature from trapped fluids in calcite veins, pore-water composition (from authigenic components) and an overall evaluation of reservoir sands.

THE STONEY CREEK OIL AND GAS FIELD PROJECT[1]

Steven L. Foley

The Stoney Creek Oil and Gas Field, located 16 km south of Moncton, New Brunswick, adjacent to Highway 114, is the only producing oil and gas field in Maritime Canada. The discovery well was drilled by Maritime Oilfields Limited in 1909. Subsequently, 175 wells were drilled in or adjacent to the field, with the majority of those wells completed prior to the late 1950's.

These wells were logged by the drillers and not professional geologists (St. Peter, pers. comm.). Western Decalta Petroleum Limited, in 1962, acquired the lease to the Stoney Creek Oil and Gas Field and consequently initiated a production enhancement project through water flood techniques. This pursuit flooded some of the more productive wells in the field. The poor results stemmed from the lack of knowledge pertaining to the geometry and distribution of sandstone bodies within the oil field (Barnett _et al_., 1984)[1]. Irving Oil Limited is the present lease holder and operator of Stoney Creek Oil Field. Oil production in the last few years has continued at a rate of several hundred cubic metres per year and gas production at about $2x10^6$ m^3 per year.

Oil Production:

Year	Production (m^3)
1909 to 1979	123 430
1980	600
1981	320
1982	100
1983	750
1984	450
1985	630

Gas Production:

Year	Production (m^3)
1909 to 1979	790 083 000
1980	2 200 000
1981	2 000 000
1982	1 700 000
1983	1 700 000
1984	2 100 000
1985	2 100 600

(modified after Barnett _et_ _al_., 1984)[1]

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[1] Contribution to Canada - New Brunswick Mineral Development Agreement. Project carried by DNRE and UNB.

Since the discovery of the Stoney Creek Field in 1909, a thorough geological synthesis has not been completed. The present project was initiated to provide a comprehensive data base of a high technological level. This will aid in the understanding of the facies distributions and sand body geometry, as well as the geological setting of the oil and gas field. This study was launched on June 1st, 1986. The initial thrust began with a critical review of relevant literature in order to create a working knowledge of the geological history and progression of ideas regarding the field. A limited bedrock investigation of the Albert Formation (host formation to the Stoney Creek Oil and Gas Field) was carried out in July of 1986. The data collected will be used in conjunction with a relogging of relevant drill cuttings from wells located within or adjacent to the field in order to reevaluate the geology of the area.

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COASTAL ZONE AND PEAT RESOURCES

Jacques J. Thibault, Peat Geologist

PEATLANDS

Two projects, funded under the Canada-New Brunswick MDA will have been initiated by the fall of 1986:

a) Peat Moss Market Study - A management tool
b) Use of peat in agriculture - A project to identify potential new uses for peat in agriculture-related sectors

COASTAL ZONE

Between September 10 and 14, the entire New Brunswick coastline was filmed from helicopter. The 11-hour colour recording was done on 3/4" videotape and will be available in VHS or BETA format. The entire document is to be released as a Geological Survey of Canada Open File. Funding for this project and technical support was provided by the Atlantic Geoscience Centre (AGC) Dartmouth, Nova Scotia. Dave Frobel (AGC) did the filming while Jacques Thibault narrated the field version.

GRANULAR AGGREGATE RESOURCES IN NEW BRUNSWICK

A.A. Seaman, Quaternary Geologist

GRANULAR AGGREGATE RESOURCE INVENTORY PROGRAM

This year saw the completion of the mapping portion of the granular aggregate inventory program, with the reconnaissance mapping of the five remaining unmapped parts of the province (Figure 28). These areas were, from west to east: 1) the Fundy islands (parts of NTS 21 G/2, 21 B/10, 15); 2) the northwestern portion of the Saint George map area (NTS 21 G/2); 3) the Hampstead map area (NTS 21 G/9), exclusive of CFB Gagetown; 4) the Cape Spencer map area (NTS 21 H/4); and 5) the Waterford and Salmon River map areas (NTS 21 H/6, 11), begun in 1985.

Maps at a scale of 1:50 000, outlining the surficial distribution of the aggregate deposits in the above areas, will be produced this year. The final reports to accompany these maps will be completed in the following fiscal year.

AGGREGATE COMPILATION ATLAS

A provincial contract under the federal-provincial Canada-New Brunswick MDA was awarded to Wim D. Vanderklift of Fredericton, N.B. to produce an aggregate compilation atlas. This atlas, at a scale of 1:100 000, is conceived as a means of summarizing, and providing reference to, the more detailed 1:50 000 scale aggregate resource maps produced during the course of the granular aggregate inventory program. Completion of the atlas is scheduled for March 31, 1987.

Also under this contact, a number of the earlier detailed aggregate maps are being upgraded to current standards.

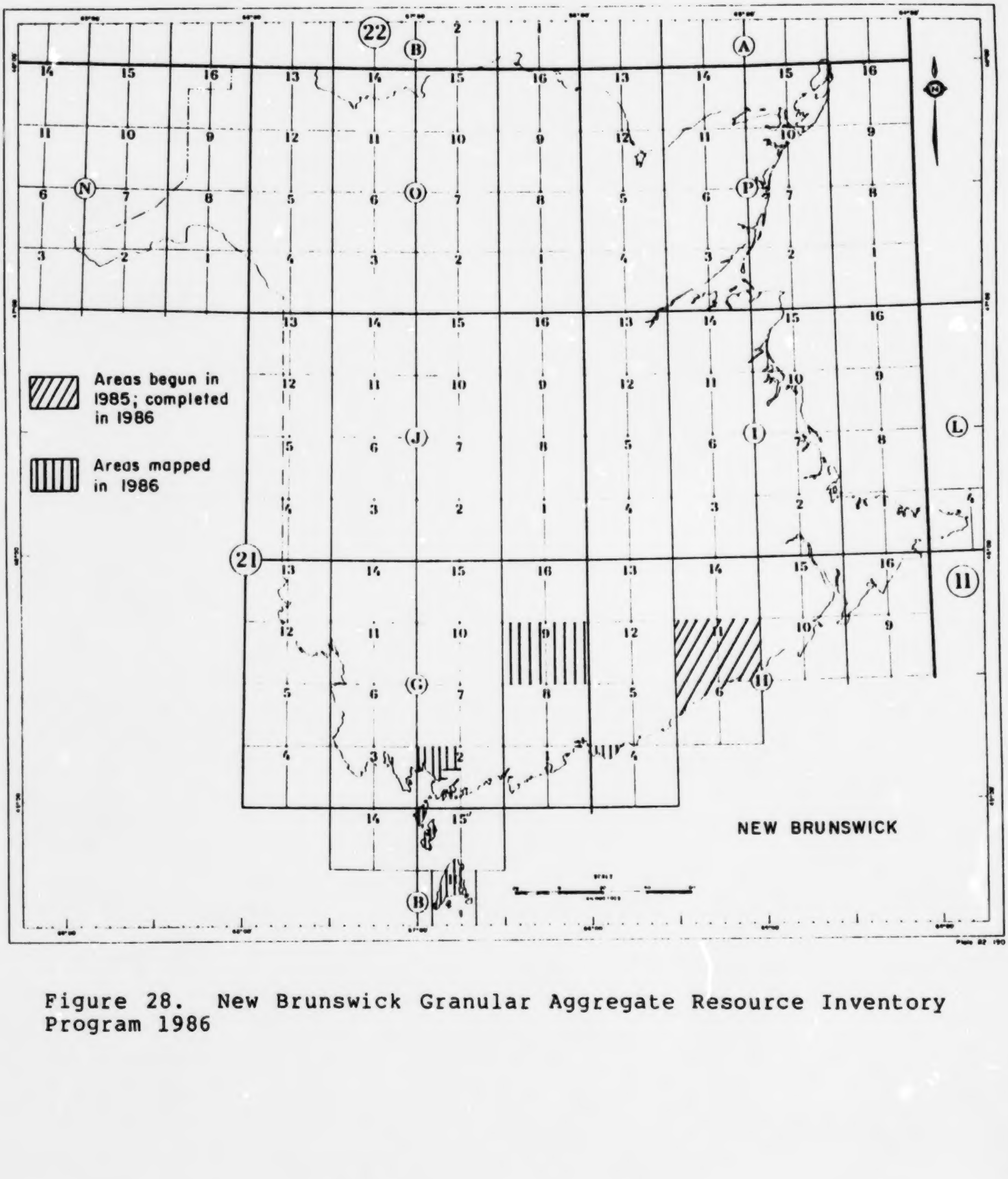

Figure 28. New Brunswick Granular Aggregate Resource Inventory Program 1986

UNIVERSITY OF NEW BRUNSWICK

REPORT OF ACTIVITY
DEPARTMENT OF GEOLOGY AND GEOLOGICAL ENGINEERING PROGRAM
UNIVERSITY OF NEW BRUNSWICK

W.E. Hale

GENERAL

Eight geologists and seven geological engineers graduated from UNB since our last report. This graduating class was exceptional in the number of honours, dean's listing, and prizes awarded to its members. Two of the geological engineers won NSERC post-graduate scholarships. All of the graduates were employed for at least the summer.

Seven persons completed their MSc's, and two PhD's were awarded for work within the Department.

Members of the faculty and graduate students published approximately 50 scientific papers and abstracts.

The geological engineering program received accreditation for the next five years from the Canadian Council of Professional Engineers. A new course in Hydrogeology is being offered this year.

The Department comprising 16 full-time faculty, 7 technical staff and 3 support staff, 11 PhD and 9 MSc resident and 5 non-resident post graduates, (seven of whom are working on N.B. projects), 98 undergraduate students (45 science majors in geology and 53 geological engineers) operated during the past year with university budgets of approximately $1,000,000 for salaries and $98,000 for non-salary expenses. The NSERC supported the Department's research in the amount of $220,606 for the year and the MPHEC provided $33,134 for research equipment during 1985-86. Research contracts for varying periods were negotiated; the Heath Steele Mine project (supported by funds and services from DNR, EMR, and the Noranda Group of companies in the amount of $214,000/yr., renewable for three years), various projects with EMR in the amount of $145,585, other projects with DNR amounting to $56,290, and smaller amounts from the UNB Research Fund, Seabright Resources, Inc., Chevron, and others.

Dr. P.F. Williams completed his tenure as Chairman of the Department at the end of June and embarked on a well-deserved sabbatical during which he will visit and lecture in Australia, China, Japan, New Zealand, Europe, and U.S.A. His academic responsibilities at UNB have been assumed in part by Dr. Charlotte Hy, a post-doctorate fellow and graduate of the University of Paris, France. Dr. W.E. Hale replaced Dr. Williams as Chairman. Dr. C. Mawer left to join the faculty at the University of New Mexico. Dr. J.G. Spray, a graduate of Cambridge University, took up his regular duties as metamorphic petrologist in January, 1986. Dr. J.T. Dunn, a graduate of the Universities of Washington and Alberta, and most recently employed by Atomic Energy of Canada Ltd., joined the Department as Igneous Petrologist in August.

Dr. H.W. van de Poll is on sabbatical leave during the current academic year in which he will persue his interests in the Carboniferous in Holland, Spain, and England. Dr. K.B.S. Burke is also on sabbatical leave and is studying historical seismicity at Ottawa and in England. J. Chandra has agreed to lecture in geophysics during Dr. Burke's absence.

GEOCHEMISTRY

Dr. N.J. Susak is continuing studies of metal solvation and transport mechanisms. Spectrophotometric studies on cobalt-chloride complexes are complete to 90°C. Construction of high temperature cells, to extend these studies to 300°C, is nearly complete. He has also initiated a hydrothermal solubility study of cobalt and nickel oxides.

GEOPHYSICS

Dr. K.B.S. Burke completed the study of microseismic activity in the epicentral region of the 1982 Miramichi earthquakes. It was found that the activity during the period 3 July to 19 August, 1985 was episodic. Composite fault plane solutions yielded a plane dipping to the west at 82° and striking 162° for foci above 4 km, changing to a dip of 42° and strike of 197° below that depth.

Coda magnitude relationships for the Miramichi epicentral area have been investigated by two BSc students under Dr. Burke's supervision.

Dr. Burke and S. Slauenwhite have started an investigation of the historical seismicity in the southwestern part of N.B. under contract with the Geophysics Division of the GSC.

G.A. Allcott has continued his evaluation of magnetic and VLF methods at the Heath Steele Mine as part of the Federal-Provincial MDA. An analysis of results obtained during the past summer is currently in progress.

MINERAL DEPOSITS

Economic geology activity, under the general supervision of Dr. A.L. McAllister, is focused mainly on Appalachian mineral deposits with emphasis on massive sulphides.

One project at Brunswick No. 12 Mine is to study the nature and distribution of gold and the possible relationship between gold deposition and the different stratigraphic units, alteration zones, intrusions, and structures. It is hoped that the results will be useful in the exploitation of other similar deposits in the area.

At Heath Steele Mines a three-year project jointly sponsored by the Federal and Provincial Governments has been initiated under the direction of Dr. P.F. Williams. The object is to provide a general assessment of the geological structures, define the distribution of stratigraphic layers, and ultimately, to use these data to locate additional ore reserves. A full time co-ordinator, Mr. J. Torrance, has been appointed to the project which involved, in 1986, one PhD student, one MSc student doing geophysics, and three assistants.

Work is also continuing on certain other massive sulphide, gold, and tungsten deposits in the Atlantic Provinces.

Dr. D.J. Bachinski and his graduate students continue work on massive sulphide occurrences in the Canadian Appalachians with detailed studies on Fe-Cu-Zn deposits in the Fournier Group and in Newfoundland. He has also initiated studies on red bed copper and porphyry copper deposits. Dr. Bachinski and Dr. McAllister are supervising a BM & S-supported study on gold in the Bathurst-type deposits.

Dr. H. Hassan, Dr. W.E. Hale, and M. Chrzanowski completed a metallogenetic study of uranium and associated elements under a GSC-MDA contract. Results of this study are on open file at the GSC, Ottawa. The same team has embarked on a new three-year study, under the same auspices, on the potential for uranium and associated element potential in the Miramichi Anticlinorium domain.

Two MDA-supported projects; one on geotechnical properties of backfill in potash mining and another on heavy minerals in alluvium have been completed by students working with Dr. Hale.

Dr. Hale, M. Chrzanowski, and C.G. Elliott are investigating a beryl occurrence near Zealand in central New Brunswick.

Dr. H.W. van de Poll continues his interest in the economic geology of the Permo-Carboniferous of N.B., N.S., and P.E.I. with emphasis on the lithostratigraphy, sedimentology, and paleoclimatic evolution of coal basins and the Prince Edward Island redbeds for an overall evaluation of their economic potential with respect to coal, gravel, copper, uranium, and natural gas.

Dr. J.P.A. Noble is continuing supervision of the MDA-sponsored project, "Diagenesis of the Albert Formation", with graduate student, Ali Chowdhury, and is now supervising a new sedimentation project on the Stoney Creek field with research associate, Steve Foley, and Clinton St. Peter of the DNRE.

Dr. J.G. Spray is presently studying an Archaean greenstone-hosted Ni-Cu-Co deposit from the Furnas terrain of Brazil following fieldwork there in 1984. Particular emphasis is being placed on characterizing the komatiite host despite metamorphism to the amphibolite facies. Comparisons are also being made with Western Australian examples, e.g., Kambalda. The Furnas body is one of the first major greenstone-hosted nickel sulphide deposits to be discovered in Brazil.

PALAEONTOLOGY

Dr. A. Logan is continuing actuopalaeontological studies of modern hard substrate communities in the Bay of Fundy with a view to ascertaining their value for palaeoecological reconstruction in the Mesozoic. He is also working on competitive interactions of hermatypic corals in Bermuda and their significance in terms of distribution and succession of similar species in Tertiary and Pleistocene reefs.

Dr. J.P.A. Noble together with graduate students continues his studies of Palaeozoic fossil assemblages with emphasis on Silurian corals and stromatoporoids and the relation of the New Brunswick and Gaspé faunas to those of other circum-Atlantic areas as a 'tool' in reconstructing plate movements.

Dr. R.K. Pickerill, who this year completed his role as Chairman of the Trace Fossil Research Group of the S.E.P.M., is continuing work on the structure, composition, ecology, and evolution of Silurian brachiopod-dominated communities of Arisaig (N.S.). Additionally, he is making a study of the structure, composition, and evolution of Ordovician marine benthic communities in Quebec with Dr. T.L. Harland and in Wales with Dr. P.J. Brenchley. He is also collaborating with Dr. M. Wade of the Queensland Museum, Australia, in a study of Cambrian jellyfish from the Saint John area. He continues his extensive trace fossil research in Spain, Portugal, Quebec, Newfoundland, New Brunswick, Alaska, Oregon, southern California, and northern Greenland.

PETROLOGY

The Department experienced a tragic loss in the unexpected death of Dr. S.W. Bachinski on 14 March, after a brief illness. She had successfully battled cancer twice previously. Sharon served the Department with originality, scientific expertise, devotion, humanity, humour, and colour. Her research on lamprophyres is being completed by associates. Her interest in and contribution to students will continue to be missed with great sadness.

Dr. J.T. Dunn, the Department's igneous petrologist, arrived in August 1986. Dr. Dunn's research interests include the kinetics of igneous processes, crystal/melt equilibria, and the application of stable isotope geochemistry to petrologic problems.

Dr. J.G. Spray, who joined the Department in January 1986, is continuing his work on the petrology of Archaean and Phanerozoic ultramafic-mafic complexes with particular emphasis on metamorphic processes. Material from Brazil, Western Australia, and New Brunswick is currently being investigated. In addition, a new Friction Laboratory is being established to study shear heat phenomena in fault zones.

Dr. L.T. Trembath is studying crystallization of feldspar in synthetic and natural systems. This latter project is concerned with a comparison of microstructure in natural and experimentally produced compositionally equivalent crystalline material and is aimed at developing a better understanding of the crystallization and emplacement of granitoids.

REGIONAL MAPPING PROJECTS

Several members of the Department continue to be active in regional studies: R.H. Grant is continuing with his studies of Variscan tectonics west of Saint John; Dr. R.K. Pickerill, in collaboration with Dr. K.L. Currie of G.S.C., Dr. D. Nance of the University of Ohio, and a graduate student, is involved in regional mapping in the Saint John area (N.B.); I. Patel is working on the Precambrian-Cambrian boundary in New Brunswick. Dr. J.P.A. Noble is continuing his regional stratigraphic studies of the Silurian-Devonian of northern New Brunswick. Dr. P. Stringer has been investigating Acadian cleavage in mainly Siluro-Devonian rocks in southwest New Brunswick and adjacent Maine.

Graduate students of Dr. H.W. van de Poll are continuing mapping and basin analysis of Carboniferous and Lower Permian Strata in eastern Canada and have specific project areas at present, around Tatamagouche (N.S.), Parrsboro (N.S.), the Sydney Basin (N.S.), and on Prince Edward Island.

Postgraduate students working under Dr. Williams' direction continue mapping in the Dunnage Zone around eastern Notre Dame Bay (Nfld.).

SEDIMENTOLOGY

Dr. J.P.A. Noble is continuing with stratigraphic and sedimentary studies, including a study of diagenesis, in northern New Brunswick and Gaspé as part of a Silurian-Devonian Appalachian basin project.

I. Patel is continuing a study of the sedimentology of the Lower Cambrian Ratcliffe Brook Formation in southeastern New Brunswick and is attempting correlation with similar sequences in parts of the northern Appalachians and Europe.

Dr. R.K. Pickerill is contributing sedimentological work to a regional study of the Saint John Group, as mentioned above, and a PhD student is currently writing his thesis. Additionally, he is continuing his extensive studies of Middle Ordovician sedimentation of the Trenton Group carbonates of Québec.

In addition to the obvious sedimentological bias of their regional project mentioned above, Dr. H.W. van de Poll and I. Patel are continuing work on physical diagenesis. They are augmenting this study with laboratory tank experiments, by means of which they are replicating many of the structures observed in the field. This work has implications for petroleum reservoir studies, facies analysis, and paleoseismic interpretations.

STRUCTURAL GEOLOGY

Dr. P. Stringer is continuing structural mapping in southern New Brunswick on the supposed Triassic Lepreau Formation. Carboniferous palynological dates indicate that parts of the Lepreau Formation are pre-Triassic, and locally intense deformation is correlative with the Alleghanian (late Carboniferous) orogeny.

Electron microscopy research carried out by Dr. J.C. White has included characterization in ZnP_2 of features that influence its electronic properties, as well as elucidation of deformation and exsolution phenomena in deep crustal feldspars. A study of the Cobequid Fault zone, Nova Scotia has been completed and examination of microstructures and microchemistry of hanging-wall and foot-wall rocks in the Hemlo, Ontario gold deposit is nearing completion.

Dr. P.F. Williams and students are working on major faults in Atlantic Canada including the Dover Fault, Newfoundland (with A. Caron), faults in southern New Brunswick (with A. Leger), the Cobequid-Chedabucto Fault, Nova Scotia (with C. Mawer), the Indian Islands Fault, Newfoundland (with B. LaFrance). The objective of these studies is to synthesize Acadian ductile and brittle faulting history as a basis of understanding its influence on Carboniferous sedimentation and emplacement of quartz and calcite veins, many of which are related to the faults.

Dr. Williams is continuing research on a structural study and implications of shear zones in the Shelburne, Nova Scotia area (with D. Keppie and S.J. Hwang); an MDA-funded project to investigate the geological history of gold-bearing veins in Nova Scotia (with C. Hy), and has undertaken a new GSC-funded project at Thompson Mine, Manitoba (with W. Bleeker and C. van Staal).

On September 23, 1986, Dr. W.E. Hale passed away. He will be sadly missed by all who had the pleasure to know him.

GEOLOGICAL SURVEY OF CANADA

FIELD RELATIONS, PETROLOGY, AND AGE OF GRANITOID ROCKS OF THE POINT WOLFE PLUTON (EASTERN HALF) AND ASSOCIATED METAVOLCANIC AND METASEDIMENTARY ROCKS, CALEDONIAN HIGHLANDS, NEW BRUNSWICK[1]

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During July and August, 1986, an area of about 300 km^2 covering the eastern half of the Point Wolfe pluton and adjacent metavolcanic and metasedimentary rocks was mapped at a scale of 1:20 000. The map area adjoins that mapped in 1985 (Barr and White 1985; Barr, in press) and completes a traverse across the Caledonian Highlands from the Bay of Fundy coast north to the Carboniferous cover rocks.

Results from the study of the 1985 map area (Barr, in press) have documented the field relations and petrology of three main plutonic units, the Forty Five River granodiorite, Goose Creek leucotonalite, and Alma diorite. A Rb-Sr whole-rock isochron from the Fortyfive River granodiorite indicated an age of 597 ± 18 Ma, and an essentially identical age of 598 ± 27 Ma was obtained by the K-Ar method on hornblende from the Alma diorite. These ages confirm that these rocks are Late Precambrian like similar plutons in southeastern Cape Breton Island, Nova Scotia, thus strengthening correlations between these areas and supporting their Avalonian affinities. Petrographic and geochemical studies of the granitoid rocks showed that they display typical calc-alkalic, I-type characteristics.

The pluton ages also confirm a Precambrian age for the host metavolcanic and metasedimentary rocks. The metavolcanic rocks consist mainly of plagioclase-rich crystal tuffs, lithic crystal tuffs, basalt, and rhyolite, now containing mineral assemblages consistent with lower greenschist facies metamorphism. Geochemical studies suggest that these rocks are tholeiitic, and formed in a continental-margin volcanic environment.

The 1986 map area to the north is dominated by the Point Wolfe River pluton, a large composite intrusion consisting of mappable bodies of (in inferred sequence of emplacement) diorite, hornblende granodiorite, hornblende granite, and leucogranite, as well as various minor units. None of the units appear identical to those of the Forty Five River, Goose Creek, and Alma plutons documented by the 1985 study, although they display similar features such as the presence of hornblende as the dominant mafic mineral, and it is likely that all these plutons are comagmatic and of Late Precambrian age.

The host rocks of the pluton are similar to those in the 1985 map area. Epidote-rich amygdaloidal metabasaltic rocks are widespread and occur at several levels in the stratigraphic succession; however, the main basaltic unit is underlain by distinctive ignimbritic rhyolite flows and tuffs, in turn underlain by metasedimentary and pyroclastic units. The metasedimentary rocks include arkose, arkosic conglomerate, grey and brown slates and phyllites, and minor quartzite.

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[1] Contribution to Canada - New Brunswick Mineral Development Agreement. Project carried by Geological Survey of Canada.

RECONNAISSANCE STREAM SEDIMENT AND WATER SURVEYS AND RELATED GEOCHEMICAL STUDIES IN NEW BRUNSWICK[1]

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As part of the Canada - New Brunswick MDA (1984-89), a two-part applied geochemical program is being undertaken. The first component involves regional reconnaissance stream sediment and water surveys jointly planned by the GSC and New Brunswick Department of Natural Resources and Energy (DNRE), Geological Surveys Branch. Although the primary objective is to assess the mineral potential of selected regions and to recognize specific areas of mineral interest, the surveys also increase the geochemical data base of the Province and provide information that will help refine the methodology of future programs. The second component consists of orientation and follow-up studies designed to aid in the interpretation of the reconnaissance data and to develop and evaluate new stream sediment methodology.

REGIONAL RECONNAISSANCE SURVEYS

During July and August of 1985 the first National Geochemical Reconnaissance (NGR) survey covering 3 900 km^2 was carried out in northwestern New Brunswick (Figure 29). Stream silts and water samples were collected from 598 sites at an average density of one site per 6.5 km^2. After sieving (minus 80-mesh) and ball-milling, the sediment samples were analysed for Zn, Cu, Pb, Ni, Co, Ag, Mn, Cd, Fe, Mo, V, As, Hg, U, LOI (loss-on-ignition), F, Sb, W, Ba, Sn, and Au. Uranium, pH, and F were determined on the waters. The data was released on July 2, 1986, as GSC Open File 1211, consisting of 25 maps and 88 pages of text. Approximately 1,900 hectares were staked following the release (up to mid-September) mainly in areas of anomalous gold responses (e.g., St. Aubin and Menneval regions).

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[1] Contribution to Canada - New Brunswick Mineral Development Agreement. Project carried by Geological Survey of Canada.

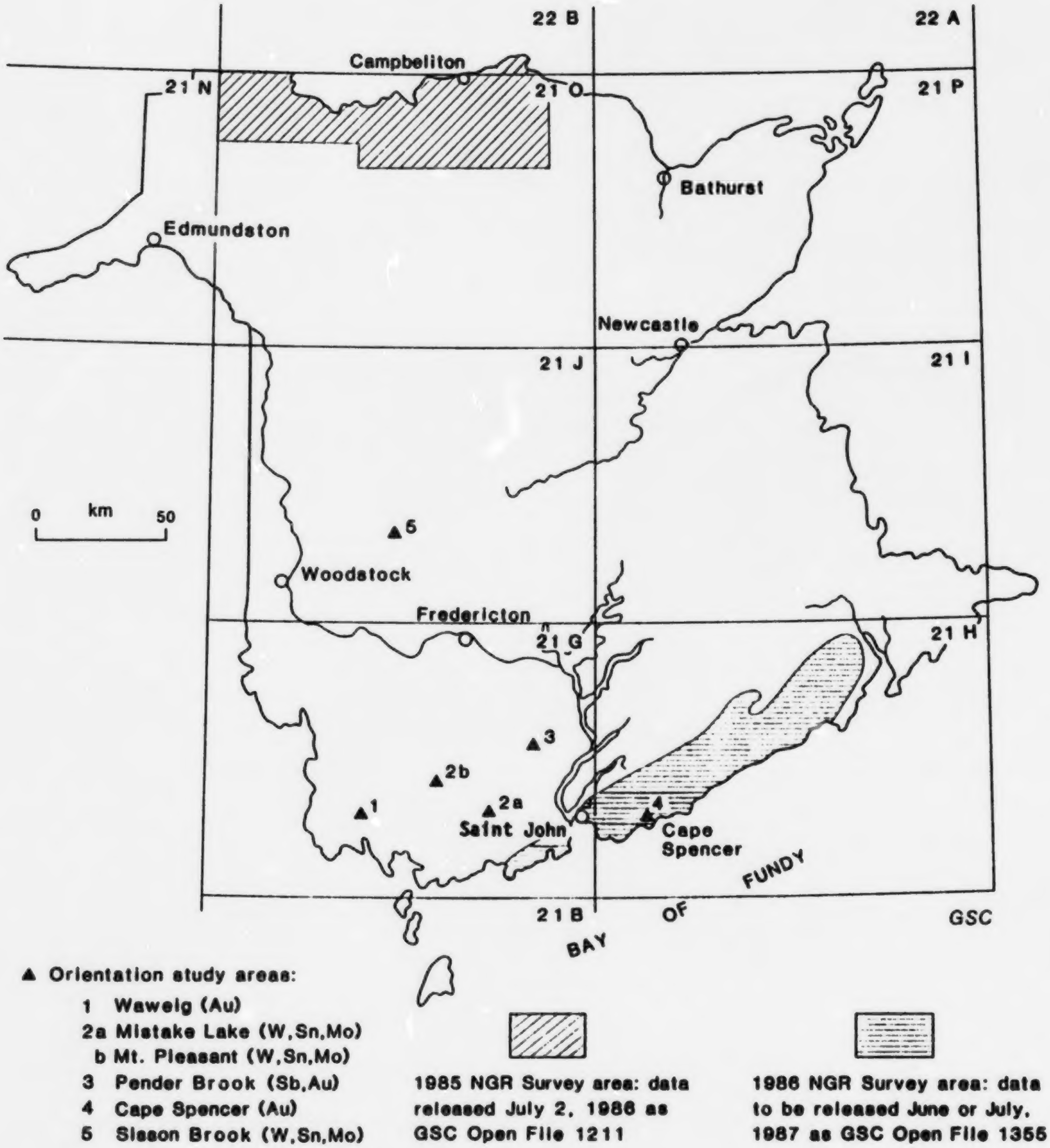

Figure 29. Location of National Geochemical Reconnaissance surveys and orientation study areas in New Brunswick.

Sample collection for a second survey, in the Bay of Fundy coastal area (Figure 29), was completed during August and September, 1986. Concomitant stream-silt and water samples were collected from 757 sites (area is approximately 2 500 km^2, average sample density is approximately 1/3.3 km^2). The samples will be analysed for the same suite of elements as last year's survey. The data will be released as GSC Open File 1355 in June or early July 1987. Copies will be available from DNRE, Geological Surveys Branch, Fredericton; Regional Geologists Office, Sussex; Campbell Reproductions, Ottawa.

ORIENTATION WORK

Detailed stream sediment and water sampling was undertaken in the vicinity of several known mineralized areas (Figure 29). Because one of the major objectives of the study is to compare the effectiveness of various sample media, particularly stream silts versus heavy mineral concentrates, emphasis was placed on areas with Au-, W-, or Sn-occurrences. Historically, heavy mineral surveys have been considered the best, and in some cases the only, method in detecting these types of mineralization or others which are considered to be dispersed in the surficial environment primarily as detrital grains (e.g., gold, cassiterite, scheelite, ...).

Detailed study sites were selected to reflect both background and anomalous situations in each area. At every site a water sample and stream sediment material were collected. The stream sediment material was used to derive five different sample media, namely (1) stream-silt (standard medium collected during reconnaissance surveys); (2) heavy-silt; (3) pan-concentrate; (4) mid-density mineral concentrate (sp. gr. 2.8 to 3.3); (5) heavy mineral concentrate (sp. gr. greater than 3.3). Sediment samples were analysed for Zn, Cu, Pb, Ni, Co, Ag, Mn, Cd, Fe, Mo, V, As, Hg, U, LOI, F, Sb, W, Ba, Sn and Au. Uranium, pH, F, SO_4, Cl, NO_3, PO_4 and conductivity were determined on the waters. Representative samples of mineralization and host rock were also collected and analysed for the same elemental suite as for the sediments.

Preliminary interpretation of the data indicates that the dispersion haloes defined by the five stream sediment media are remarkably similar and that each effectively reflects the known mineral occurrences. Anomalous element suites determined for each area are listed in Table 4.

Table 4

Anomalous element suites in stream sediment material within each of the study areas. Elements considered to exhibit a strong response are listed first, shown in brackets, by those with a moderate to weak response.

Area (associated mineralization)	Anomalous Element Association
Waweig (Au)	(Au, W?)
Mistake Lake Mount Pleasant (W, Sn, Mo)	W, Mo (As, Sn, Zn, Cd)
Pender Brook (Sb, Au)	Sb (Au, As)
Cape Spencer (Au)	Au, W (U)
Sisson Brook (W, Sn, Mo)	W, Mo, Cu, As, Ag (Sn, Cd)

In general the stream silts give a measure of hydromorphic and fine-grained mechanical dispersion, whereas the heavy mineral concentrates reflect mechanical processes. The fact that all five of the stream sediment media prepared reflect the known mineralization strongly suggests a significant hydromorphic as well as mechanical component to the dispersion trains even for elements (e.g., Au, Sn, W) generally considered to be largely mechanically transported.

In the Canadian Cordillera, heavy mineral surveys have been used most effectively because of the high-energy stream environment. In comparison, New Brunswick has relatively moderate relief and higher groundwater activity. These are likely important factors in the formation of the significant hydromorphic dispersion haloes encountered in the study areas.

In summary, interpretation of preliminary data suggests that stream silts are an effective sample medium for detecting Au, Sn, W-bearing mineralization in New Brunswick. Moreover, the significant hydromorphic dispersion haloes identified suggest that stream-silts may detect mineralization in situations that are not amenable to detection by standard heavy-mineral surveys (e.g., blind deposits, deposits in areas of relatively low relief).

LITHOGEOCHEMICAL STUDY OF RED MANGANIFEROUS SLATE AND BLACK SLATE-CHERT IN MIRAMICHI ZONE, NEW BRUNSWICK[1]

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Geosleuths, under contract to the Geological Survey of Canada, is undertaking a study of certain Ordovician sedimentary rocks which are part of the Tetagouche Group and its equivalents throughout the Miramichi Tectonic Zone. Our attention is focused on those beds in which chemical sedimentation has been important, and which lie above Cambro-Ordovician quartzite and greenish-grey slate and below Upper Ordovician dark grey turbidite wacke, slate, and volcanic rocks. These beds interfinger with basalts in the area northwest of Boiestown, extending northeast to Wayerton. To the southwest, from Millville to Eel River, and to the northeast, in the Bathurst area, these intervening beds are dominated by felsic and mafic volcanic rocks with chemical and clastic sedimentary interbeds. In the Elmtree Zone north of Bathurst, red and black slates lie within wackes and also between basalt flows that are regarded as part of an ophiolite complex (Rast and Stringer 1980).

The beds in some places pass from red, manganiferous slate upward through green slate to black slate which is siliceous or pyritic in part. This is the case at the well-studied section at Lower Birch Island on the Southwest Miramichi River at 18 km above Boiestown (Poole 1963; Irrinki 1980). However, 10 km to the northwest and across a major anticline, only black, sulphidic chert and slate are interlayered with basalt. At Winding Hill, 21 km to the southwest, red, manganiferous slate appears to be underlain by black slate and dark green, pyritic chert. In the volcanic-dominated sequences to the southwest and northeast, numerous sedimentary interbeds are found with variable arrangements of adjacent rocks. In the northeast part of the Bathurst area, van Staal (1986) has described an orderly pattern where iron formations, including oxide facies rocks, are interlayered with felsic volcanic rocks and related clastic sedimentary rocks. However, a little higher in the stratigraphic sequence, manganiferous, red slate and chert flank or are interlayered with basalts. Black, commonly graphitic slates are present both lower and higher in the sequence.

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[1] Contribution to Canada - New Brunswick Mineral Development Agreement. Project carried by Geological Survey of Canada.

As work proceeds, attention is being paid to regional relationships. The setting along the southeast side of the Miramichi Zone appears to be analogous to migrating foredeeps in Proterozoic basins as reviewed by Hoffman (1985). The local enrichment of manganese may fit models presented by Force _et al_. (1983) for areas surrounding a basin during an anoxic event. Literature about time-equivalent rocks in Nova Scotia, Gaspé, Newfoundland, and Maine is being reviewed.

With the assistance of D.V. Venugopal, approximately 90 sites will be sampled to achieve a good geographical distribution and include the full variety of depositional and stratigraphic settings. University theses have been reviewed in selecting sampling sites. At each site, detailed maps are made of the outcrops at scales between 1:100 and 1:2000. Between one and five channel samples (1.0 m long) are being collected at each site to represent the lithologies present. Most of these samples will be analysed for as many as 42 major and minor elements. Some duplicate samples will be analysed for 21 minor elements. Approximately 300 samples will be analysed. Statistical treatment of the results will be attempted. Thin and polished sections of selected rock specimens will be examined under the microscope.

The better exposed sections are being examined in the field by Dr. R.K. Pickerill, University of New Brunswick, who will provide an overview and insights during the interpretive stage. However, tectonism has obliterated many details that are useful for sedimentological interpretation. Close watch is kept for fossils. One important new site has been found near Nine Mile Brook in the Bathurst area, at about the stratigraphic position of the well-documented Camel Back Mountain limestone site, 30 km to the west-northwest (Kennedy _et al_. 1979; Nowlan 1981).

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A PROGRESS REPORT ON THE SURFICIAL GEOLOGY AND TILL GEOCHEMISTRY PROJECT, MIRAMICHI ZONE, NEW BRUNSWICK[1]

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Reconnaissance sampling of till has now been completed over most of the eastern sector of the Miramichi Zone (Figure 30). In the summer of 1986, detailed work has also been conducted in two specific areas, e.g., the Hayesville and the Charlo - Pointe Verte - Bathurst areas.

Surficial till geochemistry around the late Devonian tin-bearing granites of the Hayesville area defines a regional eastward to northeastward glacial dispersal pattern for tin, uranium, and arsenic. Systematic backhoe trenching (intervals of 250 m) has been conducted over the Todd Mountain area and around the Dungarvon and Burnthill granites. Till profiles demonstrate the vertical compositional variability of the glacial sequence and confirm the existence of two glacial depositional events. Sheared organic matter was observed at the base of the upper till of a two-till sequence found in a trench near Todd Mountain. An interstadial organic-bearing paleosol (?) was also discovered in the Half Moon pit, southeast of Juniper (36 000 BP; GSC-4199).

Detailed sampling has been carried out in the northern part of New Brunswick with particular attention being given to the Elmtree gold district. The geochemical analyses are still in progress. However, the geochemical results available demonstrate numerous occurrences of a small amount of gold in the silt and clay fraction of the till (5-44 ppb). At least three different ice-flow directions are recorded by striations but no evidence for multiple till deposition has yet been found. The sediments of the Elmtree moraine have been studied in detail. The interlobate nature of the moraine is questioned.

A deep overburden drilling program is to be implemented this fall in the Saint John River valley and in the Bathurst area. In 1987, till sampling should be completed along the western edge of the Miramichi Zone and detailed work will be conducted in the Plaster Rock - Tuadook Lake and Big Bald Mountain - Sevogle - California Lake areas.

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[1] Contribution to Canada - New Brunswick Mineral Development Agreement. Project carried by Geological Survey of Canada.

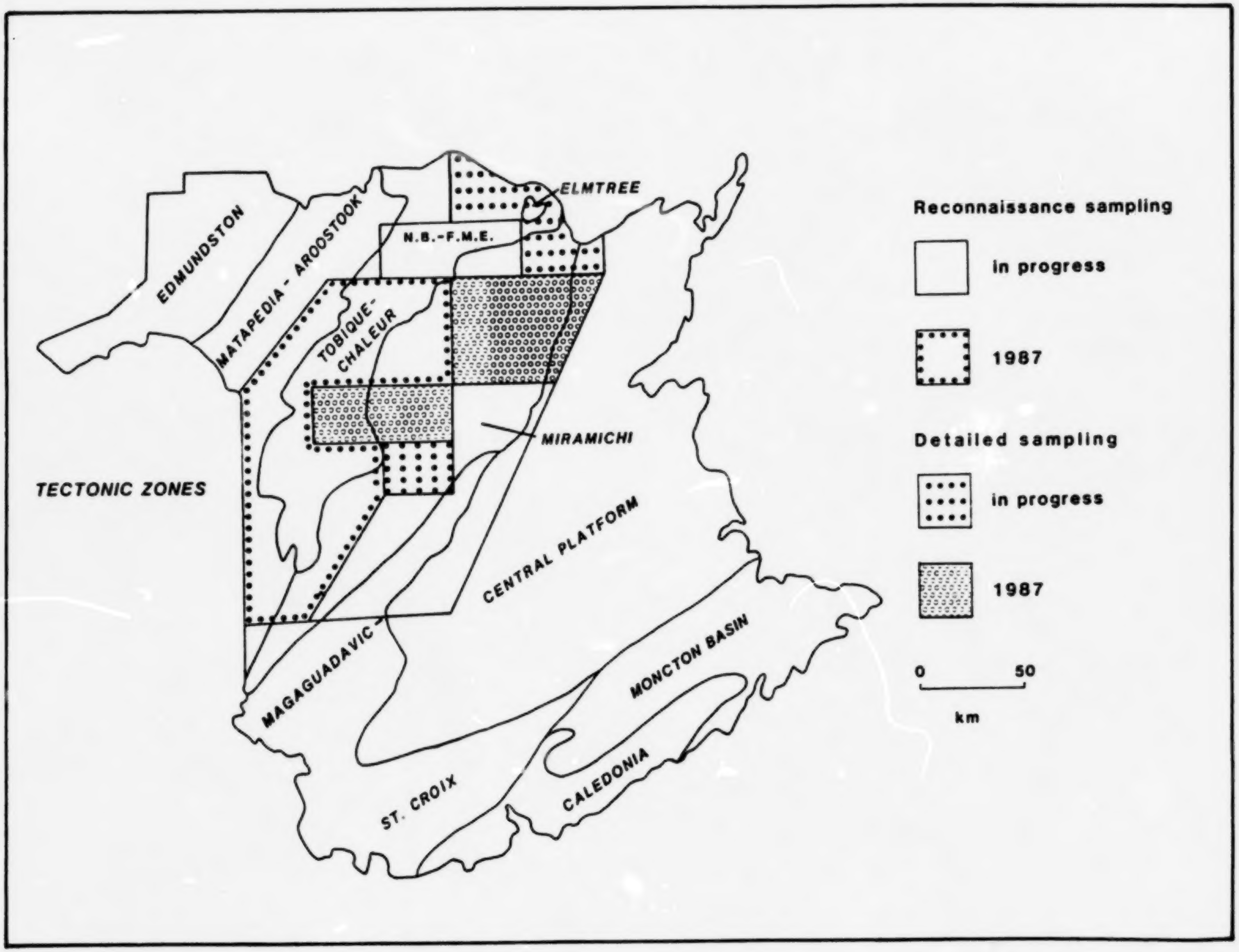

Figure 30. Canada-New Brunswick MDA till geochemistry project

PORTAGE BROOK INTRUSION, BATHURST-NEWCASTLE DISTRICT[1]

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The Portage Brook intrusion is a small mafic-ultramafic body underlying an area of approximately 10 km^2, near Popple Depot in the Bathurst - Newcastle district (Figures 31 and 32). Reconnaissance mapping of the intrusion at 1:10 000 scale, was carried out during the 1986 field season as part of the study of economic potential of Devonian mafic-ultramafic intrusions in the New Brunswick Appalachians. The Portage Brook intrusion is situated within Tetagouche Group Ordovician rocks. On the basis of geological relationships, a Devonian age was assigned to the intrusion by Helmstaedt (1971).

The intrusion is made up dominantly of troctolite. Peridotite, anorthosite, and anorthositic gabbro are the other rock types observed. The majority of Portage Brook rocks are olivine-plagioclase adcumulates and/or mesocumulates without abundant intercumulus phases. Most rocks are medium grained except for anorthositic gabbros and some peridotites where the grain size reaches 1 cm.

Layering is well developed. The layers range in thickness from several centimetres to several metres. In troctolites, layering is defined by the modal variation of olivine and plagioclase. In some cases, there seems to be slight variation in the grain size of olivines across individual troctolite layers. Anorthositic fragments are found to be aligned parallel to the plane of layering and occur along a single horizon in the sequence of layers. A planar fabric formed by alignment of plagioclase and partly by olivine grains in troctolites is usually present. In several instances, scour features are observed which, along with other features, indicate magmatic current activity during formation of the layers.

Sulphides, although minor in abundance (e.g., less than 3% by volume), are widespread in the intrusion. They consist of pyrrhotite, pyrite, and chalcopyrite which occur in the form of fine blebby disseminations and intercumulus space filling.

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[1] Contribution to Canada - New Brunswick Mineral Development Agreement. Project carried by Geological Survey of Canada.

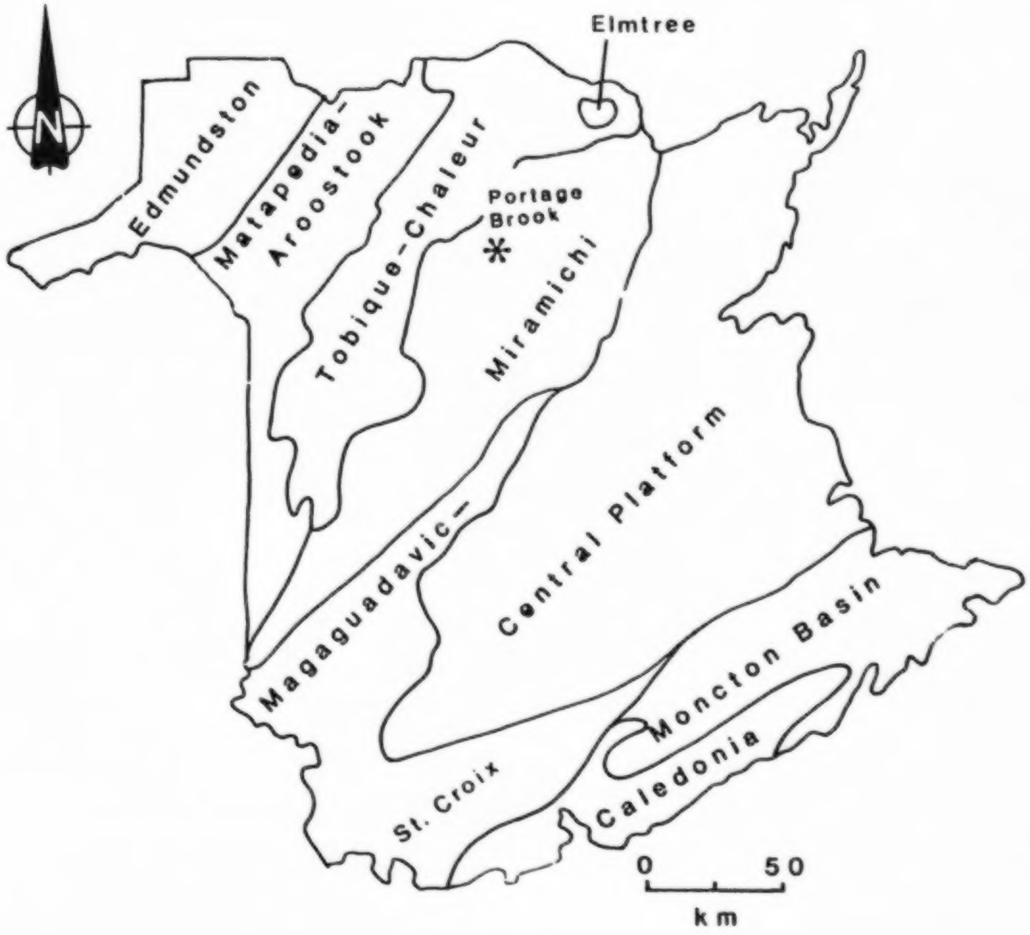

Figure 31. Location map with regard to tectonic zones of New Brunswick

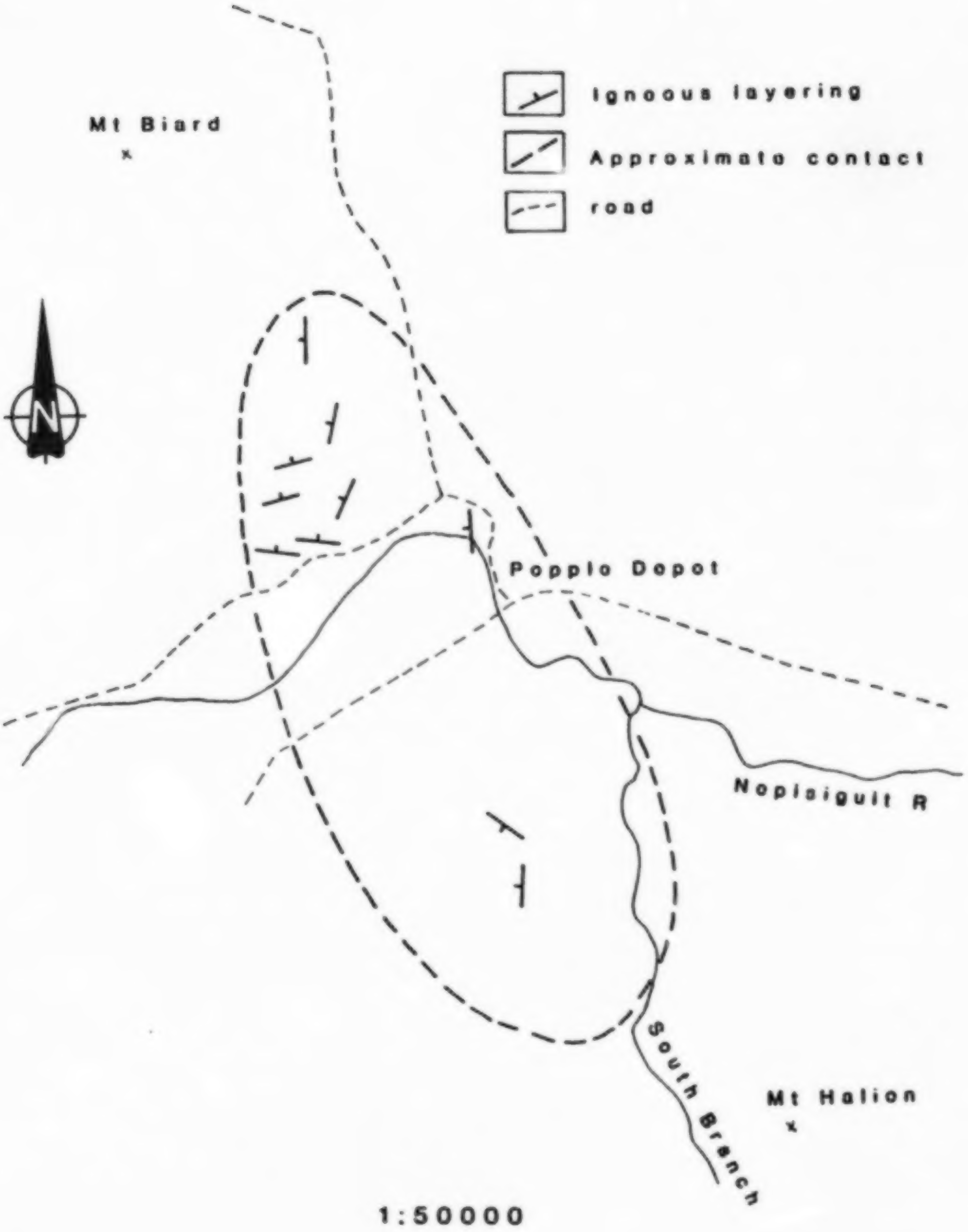

Figure 32. General geological outline of the Portage Brook intrusion.

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NICKEL-COPPER DEPOSITS OF THE ST. STEPHEN INTRUSION: SPECIAL REFERENCE TO PLATINUM - GROUP ELEMENT CONCENTRATIONS[1]

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The St. Stephen intrusion underlies an area of approximately 24 km^2 in the southwestern corner of New Brunswick. Field studies involving geological mapping of the intrusion at 1:10 000 scale and logging of diamond-drill core from about 75 holes, which started in 1985, continued during the summer of 1986.

The intrusion, consisting of peridotitic, troctolitic, and gabbroic cumulates, forms one of the many Devonian mafic-ultramafic intrusions in Appalachian-Caledonian Orogen. The intrusion appears to have been emplaced during the Acadian Orogeny (Paktunc 1986).

Ni-Cu mineralization in the form of massive, semi-massive, and disseminated sulphide concentrations is found in about 16 localities. Based on information from the assessment files and from the unpublished company reports (i.e. Atlantic Nickel Mines Limited, Boliden Atiebolag), the three largest, Rogers Farm, Hall-Carroll, and C-zone, contain resources totalling about 1 million tons at 1.05% Ni and 0.53% Cu. The dominant sulphide mineral is pyrrhotite which is found in various forms and textures in almost every rock type. It contains up to 0.54% Ni. Pentlandite is found as euhedral to subhedral grains and as exsolution blebs in pyrrhotite in peridotitic and troctolitic rocks. The pentlandite is typically rich in Co, ranging from about 2 to 8%, and in one mineralized zone Co content of pentlandite reaches 16% (Paktunc _et_ _al_. 1986). Chalcopyrite is found as irregular grains and as thin veinlets associated with other sulphides in almost every rock unit of the intrusion.

On the basis of 250 Ni and Cu analyses, including the Atlantic Nickel and Boliden assays, the St. Stephen ores and the mineralized rocks have Ni contents ranging from 0.01 to 1.90% and Cu contents from 0.03 to 3.90%. The Cu/(Cu+Ni) ratio ranging from 0.1 to 0.97, does not show a regular variation with regard to the ore type.

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[1] Contribution to Canada - New Brunswick Mineral Development Agreement. Project carried by Geological Survey of Canada.

Table 5**. Platinum-group elements, Re, Au, Ni, and Cu analyses of the sulphide-bearing samples from the St. Stephen intrusion

Sample No.	Zone	Rock Type	Sulphide Type	Os	Ir	Ru	Rh	Pt	Pd	Re	Au	Cu	Ni
65-202		SD	ds	na	na	na	na	na	na	na	na	980	1800
65-193		SD	ds	na	na	na	na	na	na	na	na	550	860
S07470	A	P	mx	na	na	na	na	10	4	na	10	340	1500
R01462	A	P frg	rm	na	na	na	na	< 15	10	na	23	1700	2000
S17315	A	M alt	sm	na	na	na	na	30	61	na	26	2400	7500
S07555	A	T	mx, rm	na	na	na	na	10	6	na	4	1600	1400
S07515	A	P	mx	na	na	na	na	10	< 2	na	3	300	380
S07450	A	P	mx	na	na	na	na	< 20	< 4	na	7	160	650
S17200	A	G	ds	na	na	na	na	< 15	< 2	na	4	100	200
S17130	A	P	mx	na	na	na	na	< 15	4	na	17	380	3200
S05235	A	P	mx	na	na	na	na	< 15	< 2	na	22	540	1600
S07570	A	T	mx	na	na	na	na	10	< 2	na	11	64	650
S17640	A	P	mx	na	na	na	na	< 15	13	na	42	4000	2900
8.317	B	OG	bb	na	na	na	na	na	na	na	na	2900	6800
S10161	C	MS	ms	na	na	na	na	45	17	na	16	7600	18300
B53093	C	OG	bb	na	na	na	na	< 15	5	na	7	1600	2100
26.362	C		ms	na	na	na	na	na	na	na	na	200	19000
S86210	G	T	ds	na	na	na	na	< 15	6	na	2	na	na
65-206	HC	G		na	na	na	na	na	na	na	na	37	47
30.170	HC		sm	na	na	na	na	na	na	na	na	3800	17000
B58239	HC	M frg	sm, rm	na	na	na	na	45	7	na	22	3300	13400
B56090	HC	OG	rm	na	na	na	na	45	53	na	9	3400	7300
S86341	J	OG	bb	na	na	na	na	< 15	< 2	na	< 1	na	na
S86342	J	OG	bb	na	na	na	na	< 15	< 2	na	< 1	na	na
86.194	K	MS	ms	na	na	na	na	na	na	na	na	310	3000
86.207	K	P	mx	na	na	na	na	na	na	na	na	330	1200
R86140	K	P	mx	na	na	na	na	< 15	4	na	5	100	140
R85122	K		sm, rm	na	na	na	na	30	20	na	23	600	1700
HM2720	K	P	mx	na	na	na	na	100	< 2	na	52	140	690
HM2715	K	P	mx	na	na	na	na	< 10	< 2	na	16	99	250
HM2545	K	P	mx	< 3	1.0	< 5	1	< 5	< 5	13	10	120	880
12.3	N	OGpeg	ds	< 3	0.1	19	1	41	< 8	< 5	10	4	8
A5.3	P	P	mx	3	0.5	< 11	2	40	< 8	5	41	1800	2200
112-3	RF	G	sm	na	na	na	na	na	na	na	na	10000	15000
B52184	RF	PT	bb	na	na	na	na	< 15	7	na	< 1	700	2200
B37197	RF	OGfrg	bb, rm	na	na	na	na	289	14	na	7	2000	2500
B36254	RF	M alt	rm	na	na	na	na	188	24	na	63	38600	1200
B29118	RF	T	sm	na	na	na	na	< 15	4	na	7	2900	7500
B36327	RF	M alt	bb, sm	na	na	na	na	< 15	21	na	33	1600	5800
B48220	RF	OG	bb	na	na	na	na	114	30	na	34	16500	2100
B40040	RF	M frg	sm	na	na	na	na	< 15	68	na	56	2000	5000
B40027	RF	MS	ms	na	na	na	na	< 15	23	na	9	5900	10500
B22424	RF		sm, bb	na	na	na	na	< 15	14	na	47	5200	7200
B21035	RF		sm	na	na	na	na	< 15	23	na	35	3500	9300
B37219	RF	OGfrg	bb, rm	na	na	na	na	30	7	na	68	20000	3800
B36134	RF	OGfrg	bb	na	na	na	na	< 15	21	na	21	1400	3600
B45042	RF	MS	ms	na	na	na	na	< 15	15	na	4	4100	16100
B35537	RF	OG	bb	< 3	1.2	< 5	2	5	24	37	23	3800	4900
B35534	RF		ms	< 3	1.9	< 5	3	6	7	14	23	570	12000
B29113	RF	G frg	bb, sm	na	na	na	na	< 15	101	na	17	1400	7000
65-199	RF	OG	bb	na	na	na	na	na	na	na	na	750	10000
65-198	RF	G		na	na	na	na	na	na	na	na	2900	9100
209-49	RF		sm	na	na	na	na	na	na	na	na	4000	10000
B37203	RF	M alt	sm, rm	< 3	1.1	< 5	1	< 5	67	< 5	20	39000	5100
B37204	RF	MS	ms	< 3	1.8	< 5	3	< 5	19	< 5	13	1500	11000
B48283	RF	MS	ms	na	na	na	na	45	6	na	11	1500	8700
15.2	S	P	mx	< 3	1.0	< 5	1	< 5	8	5	13	320	1700
20	T	T	bb	na	na	na	na	na	na	na	na	690	400
L14.1	U	MS	ms	5	1.3	< 5	3	< 5	42	26	9	1500	2200
S86281	V	T	ds	na	na	na	na	< 15	< 2	na	< 1	na	na
S86261	V	T	ds	na	na	na	na	< 15	< 2	na	< 1	na	na
S86371	W	OG	ds	na	na	na	na	< 15	< 2	na	< 1	na	na
D5.5	X	T	bb	na	na	na	na	na	na	na	na	18	79
S86361	X	OGpeg	ds, bb	na	na	na	na	< 15	< 2	na	< 1	na	na
S86362	X	T peg	ds, bb	na	na	na	na	< 15	< 2	na	< 1	na	na
S86292	Y	T	ds	na	na	na	na	< 15	< 2	na	< 1	na	na
S86141	Z	N	bb	na	na	na	na	< 15	< 2	na	2	na	na
S86131	Z	N peg	ds	na	na	na	na	< 15	3	na	< 1	na	na

**Os, Ir, Ru, Rh, Pt, Pd, Re, and Au analyses in ppb; Cu and Ni analyses in ppm. Abbreviations: G: gabbro; M: mafic; MS: massive sulphide; N: norite; OG: olivine gabbro; P: peridotite; PT: picritic troctolite; SD: sediment; T: troctolite; alt: altered; frg: fragments; peg: pegmatitic; bb: blebby; ds: disseminated; ms: massive; mx: matrix; na: not analysed; rm: remobilized; sm: semimassive.

Fifty-five samples containing varying amounts of sulphides and representing various ore types were analysed for Pt, Pd, and Au. Nine of them were also analysed for Os, Ir, Ru, Rh, and Re to get the complete spectrum of the platinum-group elements. The range of concentrations (in ppb) are: less than 3 - 5 (Os), 0.1 - 0.9 (Ir), less than 5 - 19 (Ru), 1 - 3 (Rh), less than 5 - 289 (Pt), less than 2 - 101 (Pd), less than 1 - 68 Au, less than 5 - 37 (Re) (Table 5). The Pt/(Pt+Pd) ratio varies from 0.07 - 0.95, independent of ore type and Cu/(Cu+Ni) ratio.

Se/S ratios of the sulphides display a range from $2.7*10^{-5}$ to $4.6*10^{-4}$. Although the higher values fall within the chondritic range ($2.1*10^{-4}$ to $6.2*10^{-4}$), the majority have lower ratios. Those with chondritic ratios are matrix sulphide samples which are found in direct association with the peridotitic rocks; therefore, they are the most likely candidates for being mantle-derived sulphides. Se/S ratios of the matrix and blebby sulphides show narrow ranges of variation from $8.5*10^{-5}$ to $2.9*10^{-4}$ and from $7.4*10^{-5}$ to $1.7*10^{-4}$ respectively. Massive and semi-massive varieties on the other hand, display a wide range of variation. All but one have values lower than the chondritic range. Se/S ratios of meta-sedimentary country rock define an unusually wide range from $2.2*10^{-5}$ to $8.5*10^{-3}$, covering the range of sulphides from the intrusion. The $d^{34}S$ values of the sulphides of the igneous rocks are relatively homogeneous, ranging from -2.00 to +0.44% with the exception of two anomalous results (-4.89 and -9.33%.) from the central part of the intrusion. Country rock sulphides on the other hand display a greater variation in their $d^{34}S$ values (-10.44 to +7.11%), similar to their Se/S ratios. These data support the interpretation that country rock sulphur was involved in generation of sulphides in the St. Stephen intrusion (Paktunc 1986, Paktunc et al. 1986); however, they do not entirely clarify how much mantle-derived sulphur was involved.

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FIELD OBSERVATIONS CONCERNING THE METALLOGENY OF THE WOODSTOCK AREA[1]

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A metallogenic study of the Woodstock area in the southwestern part of the Miramichi Zone was conducted in order to document the nature, distribution, and interrelationships of the known mineral deposits and to assess the potential for finding economic gold deposits. The area of investigation consists of some 300 km^2 between latitudes 46°00'N and 46°14'N and longitudes 67°26'W and 67° 41'W. Some 35 mineral occurrences, mainly of base metals, were documented, examined, and sampled.

The area is underlain by Cambrian-Ordovician quartzites, greywackes, and slates which have been intruded by Devonian granitic rocks, generally referred to as the Benton and Gibson stocks, and by later mafic dykes and gabbro. Both stocks were emplaced in several phases that range in composition from granitic to dioritic and in texture from porphyritic to equigranular.

The Gibson stock and roof pendant quartzite host porphyry copper mineralization in the Connell Mountain area. The main ore mineral is chalcopyrite which occurs as disseminations and fracture fillings in a zone of pyrrhotite, pyrite, sericite, and quartz alteration. Major fracture systems controlling the copper mineralization appear to trend northeast and northwest. Peripheral lead and/or copper (± zinc ± silver ± gold) mineralization is present as fracture fillings and in quartz veins in metasediments (mainly quartzite); these include the Wright Brook, Dominion No. 1, Cobbler-Sexton, Tompkins, and Bull Creek occurrences. The fracture systems hosting this mineralization trend predominantly northeast.

The east-central part of the Benton Granite hosts minor pyrite-chalcopyrite mineralization; the sulphides are present as fracture fillings. In the north part of the stock, roof pendant and peripheral quartzite contains minor concentrations of chalcopyrite as fracture fillings (Dugan Road). Near Oak Mountain, limonitic white quartz boulders in places contain copper-gold mineralization. The veins are probably hosted in quartzite near the west contact of the intrusive.

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[1] Contribution to Canada - New Brunswick Mineral Development Agreement. Project carried by Geological Survey of Canada.

Metallic mineralization throughout the area is associated with silicification and lesser carbonatization and chloritization. The latter two are particularly common in close proximity to mafic dykes. Sericitization has been noted at several locations, particularly on Connell Mountain.

Sulphide mineralization in the quartzites is often associated with areas of intense bleaching. Epidotization is more prevalent in the Benton Granite than in the Gibson Granite.

Geochemical analyses have not yet been received. Future work will concentrate on petrographic and mineralographic studies, and a synthesis and interpretation of all available data.

STRUCTURAL GEOLOGY OF THE NORTHERN MIRAMICHI ZONE (BATHURST CAMP) AND THE ELMTREE INLIER[1]

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The area investigated is a zone of polyphase deformed Cambro-Ordovician rocks, generally known as the Tetagouche Group, in northern New Brunswick.

The main results of this summer's work are:

1) The same structural succession, comprising 5 groups of folds, is present throughout the Bathurst Camp;

2) The Tetagouche antiform, Nine Mile synform and Mullin Lake synform are giant F_4 structures;

3) The regional foliation is an S_2 transposition foliation, which defined km-scale flat and steep belts;

4) The mafic volcanics, which consist over 90 per cent of pillow basalts, and associated cherts, ferromanganiferous sediments and argillites probably represent oceanic layers 1 & 2. This is consistent with the back-arc setting proposed by van Staal (1985, in press);

5) The contact between this oceanic crustal package and underlying felsic volcanics and sediments is consistently a D_1 high strain zone where investigated. This strongly suggests that back-arc related oceanic crust was thrusted on top of continental crust;

6) High strain zones occur throughout the Elmtree Ophiolite; their shallow dip indicates that they represent thrusts. Kinematic indicators consistently suggest that thrusting was in a north-south direction.

7) Most parts of sheets 21 P/5 and 21 O/8 have been mapped at 1:10 000 scale and are being prepared for publication.

8) 250 samples were collected and each will be analysed for 32 elements. The purpose of the sampling is to test whether there is a chemical stratigraphy within the Tetagouche Group, regional correlation of rock units and a better determination of the tectonic setting of these rock units.

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[1] Contribution to Canada - New Brunswick Mineral Development Agreement. Project carried by Geological Survey of Canada.

VOLCANIC STRATIGRAPHY AND PHYSICAL VOLCANOLOGY OF PART OF THE DEVONIAN VOLCANIC SEQUENCE, PASSAMAQUODDY BAY, SOUTHWEST NEW BRUNSWICK: A PROGRESS REPORT[1]

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INTRODUCTION

A sequence of Devonian volcanic and sedimentary rocks is exposed along the coast of Passamaquoddy Bay, southwestern New Brunswick. This sequence of rocks is bordered to the north by Devonian granitoid rocks of the Saint George Batholith, to the west by the Oak Bay Fault which bisects the St. Croix River, and to the east by the St. George Fault and the rocks of the Mascarene Group (Figure 33). Pickerell and Pajari (1976) correlated this sequence of volcanic rocks with the Early Devonian (Gedinnian) Eastport Formation of Maine, and proposed that the sequence of rocks in New Brunswick also be termed the Eastport Formation.

This belt of Devonian volcanic rocks was previously mapped at a scale of 1:31 680 by Hay (1967), and at a scale of 1:126 720 by Ruitenberg (1968). Parts of the area were mapped in greater detail by Fay (in preparation) and Whaley (1981), at scales of 1:10 560 and 1:5000, respectively.

Although the area was previously mapped, details of the volcanic statigraphy, paleovolcanology, and tectonic setting are unknown. The purpose of this study is to determine the Devonian volcanic stratigraphy and facies relationships, physical volcanology, paleogeography, and volcanic evolution of southwestern New Brunswick, by detailed stratigraphic mapping of the study area.

FIELD WORK

Field work to date was completed during August, 1984 (Van Wagoner 1984) and late July - August, 1986. Mapping was done and data were plotted on 1974 and 1984 series air photographs at scales of 1:10 560 and 1:15 840, respectively. Stratigraphic sections were described on a bed by bed basis. Field work for these two years concentrated on the area between Digdeguash Harbour and Bocabec Bay, lying south of the Saint George Batholith. A total of 238 outcrop areas were described in detail.

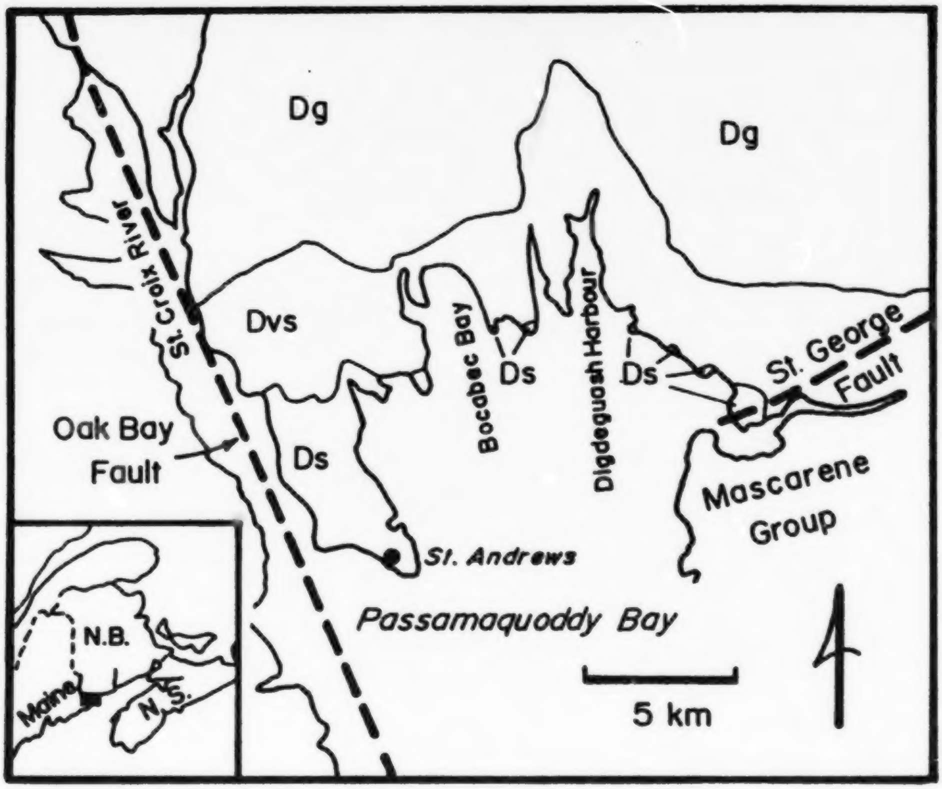

Figure 33. Index map of the study area showing the general geology after Pickerill and Pajari (1976) and Ruitenberg and McCutcheon (1980). Dg = Devonian granitoid rocks, Dvs = Devonian volcanic and sedimentary rocks, Ds = undifferentiated Silurian and Devonian rocks.

Stratigraphic sections range in thickness from 1 m to several 10's of metres. Rock samples of intrusive, extrusive, and sedimentary rock units were collected for thin section and polished slab analysis, geochemistry, and possibly for age dating.

PRELIMINARY RESULTS

The study area comprises a sequence of interbedded rhyolitic, andesitic, and basaltic flows and pyroclastic rocks; and red and green-grey shale and sandstone. The rhyolitic rocks form the thickest sequences and are the most abundant. The intermediate rocks are rare. The extrusive sequence is cut by a series of primarily basaltic sills and dykes. Rhyolitic intrusions are rare, but where they occur form resistant, mappable units.

The basalt flows were deposited in the subaerial to shallow-water transition zone environment. In places, well-preserved pillow-like breccias suggest interaction of the flow with water at shallow depth.

The rhyolite flows form thick continuous sequences that are complexly flow banded. It is difficult to identify flow tops and bottoms, or to determine the direction of flow due to the complexity of the flow banding. These flows are commonly spherulitic. Spherulites are commonly up to 0.5 cm in diameter, but rarely up to 10 cm in diameter. These flows apparently are subaerial.

The pyroclastic units range from very fine "cherty" ash tuff and crystal tuff to heterolitic pyroclastic breccia with a variety of accidental and juvenile clasts. The pyroclastic units represent near-vent air-fall deposits, distal-to-vent air-fall deposits, alternating surge and air-fall deposits, alternating surge and pyroclastic flow deposits, and thick pyroclastic flows displaying well-preserved fumarole pipes that are depleted in fine tephra. Reworked pyroclastic units are rare. Lapilli tuffs rarely contain accretionary lapilli which may be indicative of hydroclastic eruptions. In some cases it is possible to trace pyroclastic units laterally up to 3.5 km by clast type and population. Such correlation reveals striking changes in clast size, bedding thickness, and bedding structures over that distance.

The shale and sandstone represent tidal flat to beach facies rocks. These rocks are very thin to thickly bedded. Sedimentary structures include horizontal lamination, herringbone lamination, and large-scale low-angle cross lamination. These rocks are poorly fossiliferous, but highly bioturbated. In places these rocks contain layers and lenses of pyroclastic fallout. This type of sedimentation is quickly established during brief intervals of volcanic quiescence. In places, the pyroclastic units are interbedded with thin beds of bioturbated red siltstone.

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[1] This work was funded by a contract from the Geological Survey of Canada, and an NSERC operating grant.

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REGIONAL METALLOGENIC STUDIES, CHALEUR BAY BELT, NEW BRUNSWICK[1]

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Regional metallogenic studies of the Silurian and Devonian volcanic and sedimentary rocks and associated intrusions within the Chaleur Bay Belt were initiated in 1985 and continued during the summer of 1986. Of the more than 100 samples taken during last years' reconnaissance field work, 70 were analysed for abundances of 42 major, minor, and trace elements. The majority of these were mineralized and non-mineralized rocks from the Gravel Hill, Mt. Costigan, and Nash Creek deposits.

Field work this year involved a program of mapping and sampling along four traverses across the Chaleur Bay Belt from Chaleur Bay to Mount Carleton Provincial park. The objective is to determine the chemical nature and stratigraphic relationships of the volcanic rocks and assess regional tectonic implications. The data arising from this work will add to previous lithochemical studies specific to northern New Brunswick (ie. Pajari _et al_. 1977) and elsewhere in the Appalachian orogen (ie. Gates and Moench 1981) and will complement more detailed investigations currently in progress (ie. Burton, this volume).

Particular attention was paid to mapping at 1:200 scale and sampling road cuts along the new highway under construction from Belledune to Charlo. The rocks examined along a 10 km section of the new highway from the Belledune River to 2.0 km west of Jacquet River comprise a homoclinal sequence striking generally to the north and dipping to the west and southwest. Lower portions of the sequence are mafic, porphyritic, and amygdaloidal flows intercalated with siltstones, mudstones, and tuffs. Parts are dominated either by sedimentary or volcanic rocks. Upper portions of the sequence tend to be more felsic and have sedimentary intervals which are fossiliferous. Parts of the fossil-bearing units were examined in conjunction with Dr. J.P.A. Noble, UNB Department of Geology. From bottom to top of this section, the overall progression is from mafic to felsic volcanism which could represent one volcanic cycle.

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[1] Contribution to Canada - New Brunswick Mineral Development Agreement. Project carried by Geological Survey of Canada.

The porphyritic flow rocks at the base of the highway section are most distinctive with large euhedral feldspar phenocrysts and lath-like amphibole crystals set in a dark grey to maroon fine-grained matrix. Chemical analyses show these rocks to be basalts (47-48 wt% SiO_2). They are correlated with mafic volcanic rocks of the Bryant Point Formation which occur immediately beneath New Mills Formation conglomerates and sandstones along the coast section at Chapel Point (Fyffe and Noble 1985). Selected portions of outcrops along the shore of Chaleur Bay from Belledune to Charlo were also examined and sampled to provide material for regional lithochemical studies.

The other important aspect of regional metallogeny is the study of mineral occurrences both as type examples and individual expressions of metal-concentrating geologic systems. Most effort was expended in areas west and north-west of Bathurst due to the concentration of known mineral occurrences. Over twenty base metal and precious metal mineral occurrences, including the gold-bearing zones currently being investigated by Noranda and Lacana, were visited and sampled. These samples will be augmented by others previously collected by the GSC. In addition to examining whole rock chemistry and mineralogy, an objective it to obtain data on PB- and S-isotope abundances for mineral occurrence types in the Chaleur Bay Belt to compliment existing information for Ordovician massive sulphide deposits.

Areas surrounding the Mt. Costigan Pb-Zn deposit were further examined and sampled. The deposit will be the subject of a MSc thesis initiated this fall at the University of Ottawa and jointly supervised by the GSC. Other, more detailed subprojects currently in progress are remote-sensing applications to metallogeny in northern New Brunswick, alteration and stable isotope studies of gold-bearing zones associated with major structures, and genetic modelling for the Nash Creek deposit.

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STUDIES OF GRANITOID ROCKS IN NEW BRUNSWICK[1]

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Petrography and geochemical work are in progress on a suite of 285 representative samples of post-Avalonian granitoid rocks from New Brunswick. Geochemical work on these samples will classify the granite types present (ie. I-, S-, A-, or M-type (igneous-, sedimentary-, anorogenic-, or mantle-type)), help identify the tectonic environment in which they formed and indicate granites with possible economic potential.

During 16, samples were collected for a U-Pb geochronological study and a common Pb isotopic study of New Brunswick granitoids. U-Pb dating samples were collected from both deformed and undeformed granites of the Central Plutonic Belt. Deformed granite was sampled from the following plutons: Fox Ridge, South Renous, Mullin Stream Lake, Sweat Hill, Meridian Brook, and Serpentine River. Undeformed granite was sampled from: Pokiok Batholith (Hawkshaw Granite and Hartfield Tonalite), Burnthill Granite, Pabineau Falls Granite, Gibson Granodiorite, and Mount Elizabeth intrusive suite (biotite granite and alkaline granite phases). In addition, the Trousers Lake Complex, and augen orthogneiss that is a candidate for basement to the Miramichi Massif (Fyffe, oral communication, 1986), was sampled for U-Pb dating. Work is also in progress on 27 Rb-Sr muscovite ages from the various muscovite-bearing granites in New Brunswick. The purpose of the U-Pb and Rb-Sr geochronology is to establish precise crystallization and cooling ages for the intrusions. A common Pb isotopic study in progress involves samples from the Central Plutonic Belt, the Saint George Batholith and several Precambrian plutons of the Avalon Terrane. Lead isotopic ratios of these samples will provide information on the nature and genesis of the Paleozoic and Precambrian granitoids, and will, in combination with the U-Pb geochronology, shed light on the question of involvement of Precambrian crustal material in the genesis of the granitoids.

As well, a northern portion of the Central Plutonic Belt was mapped at 1:25 000 scale during 1986. Coverage included the undeformed Mount Elizabeth intrusive suite and portions of the North Pole Granite in addition to the deformed granites in this region. The Mount Elizabeth was subdivided into a mafic division (troctolite, pyroxene-amphibole-biotite gabbro and diabase), an eastern biotite granite and a western alkaline granite division (hybrid rocks, syenite, quartz monzonite and granite). Field evidence suggests that there was magma-mixing and hybridization between the mafic and felsic components of the intrusive suite and that all components are essentially contemporaneous. The alkaline granite intrudes Devonian felsic volcanic rocks with which it may be consanguineous. Within the area, deformed granites have been subdivided into a number of intrusive units (Popple Depot, Meridian Brook, Sweat Hill, Serpentine River, and Mullin Stream Lake granites), outcrops of which trend mainly in an east-west direction. Development of tectonic fabric within these intrusions is highly variable.

A number of areas with potential for gold mineralization have been recognized: (1) where Tetagouche Group rocks form roof pendants in the Mount Elizabeth suite, there are zones of extensive quartz veining and dyking; (2) at their contact with the alkaline granite division Devonian felsic volcanic rocks contain disseminated and fracture-filling pyritic zones; (3) deformed granited north of Serpentine Lake are cut by sulphide-bearing veins with associated alteration haloes; and (4) all the deformed granites are cut by major shear zones which could have acted as conduits for gold-bearing fluids. Also, a greisen alteration zone containing molybdenite was recognized in the eastern biotite granite of the Mount Elizabeth suite.

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NEW BRUNSWICK RESEARCH AND PRODUCTIVITY COUNCIL

OUTLINE OF ACTIVITIES AT THE NEW BRUNSWICK RESEARCH AND PRODUCTIVITY COUNCIL RELATED TO THE MINERAL INDUSTRY

Julie Melluish, Mineralogist

The New Brunswick Research and Productivity Council is a contract organization with revenues of approximately $8 million per year, for which the provincial government grant represents less than 10 per cent. It is divided into several departments, the Mineral Development and Processing Department being responsible for most of the mineral resource-related projects and the Applied Science Department being responsible for most energy-related projects.

The Applied Science Department has a program directed at applications for using indigenous fuel resources and for reducing sulphur emissions to the atmosphere. They have developed a pilot plant for circulating fluidized bed combustion of solid fossil and biofuels. The unit is three levels high and has a reactor consisting of a combustor and a solids recirculating system together with particulate waste and gas handling equipment. Measurement probes and on-line gas analyzers with electronic data acquisition provide operational control and records of test evaluation parameters. This unit is the only one of its size operating in Canada today. The intrinsic advantages of the system - high sulphur capture and good combustion efficiency with a wide variety of fuels - are capitalized on in the department's various programs such as emission control during the burning of high sulphur coals, combustion of oil shales and coal wastes, and applications to wood gasification.

The Applied Science Department, in the capacity of subcontractor to Paul Shibley and Associates Ltd., is also currently testing an innovative flotation development called air-sparged hydrocycloning in which gravitational separation in a centrifugal field is coupled to separation by froth flotation using micro-bubbles. The technique is being applied to eastern Canadian coal in order to physically remove sulphur in the form of pyrite and is expected to lead to improved recoveries of clean coal without quality deterioration or loss of thermal content. Such a process is particularly attractive when dealing with the high sulphur coals of the east. Success would allow them to be used by industry in the Atlantic region with atmospheric contamination being substantially reduced. This work is being funded by Energy, Mines and Resources Canada, CANMET Coal Research Laboratories.

The Mineral Development and Processing Department is involved in research and development within the mineral industry. It has laboratory facilities for chemical analysis and for mineralogical investigations using X-ray diffraction, optical microscopy (both reflected and transmitted light), electron microprobe analysis, and automated image analysis. The most recent acquisition is a state-of-the-art, fully automated electron microprobe with two wavelength spectrometers and an energy dispersive spectrophotometer. Quantitative microanalysis of samples anywhere from several centimetres to a few microns in size can be done for elements from Boron through the periodic table to Uranium. The microprobe also has full SEM (Scanning Electron Microscope) capabilities that allow for secondary electron imaging (particle shape dependent) and backscatter electron imaging (composition dependent). An image analyzer is fully interfaced with the microprobe allowing for automated chemical classification of individual particles, grain size analysis, liberation studies, and modal analysis.

The mineralogy group within the Mineral Development and Processing Department has been actively studying various aspects of the mineral industry such as the petrology of New Brunswick aggregates, silver content of various sulphides, detailed mineralogy of a New Brunswick manganese deposit, and the petrology and mineralogy of New Brunswick potash.

In the aggregates study, samples collected from 32 potential concrete aggregate sources in New Brunswick area were examined according to ASTM C-294 standard procedure. The purpose of the examination was to identify rock and mineral components of selected sieve fractions of each sample. As a result of the examination, four major groups of rock/mineral components that occur in variable proportions in any given aggregate source have been distinguished. The grouping has been based on physical properties of rock/mineral particles and their potential deleterious reactivity with the concrete pore fluids. The petrographic data collected at RPC will be utilized within the project entitled "Alkali Reactivity of Potential Aggregate Sources in New Brunswick" which is currently being conducted by ADI Limited in Fredericton.

A comprehensive study was carried out to determine the average silver content of sphalerite, pyrite, and chalcopyrite from Brunswick Mining and Smelting. This was done by analysing a large number of mineral grains from concentrator products using Secondary Ion Mass Spectrometry (SIMS).

A mineralogical study of samples from the Plymouth and North Hartford manganese-rich deposits near Woodstock, N.B. was also undertaken. It was determined that the dominant manganese - bearing phases are manganese - rich carbonates, manganiferous chlorites, braunite $((Mn_3Si)_2O_3)$, manganite $(MnO(OH))$, psilomelane, pyrolusite (MnO_2), hausmannite (Mn_3O_4), jacobsite $(MnFeO_4)$, pyrophanite $(MnTiO_3)$, Mn(K)Al silicates, and various manganiferous micas. The manganese often occurs as small amounts in rock-forming minerals such as chlorite and the various micas; and all the manganese-bearing phases are generally finely intergrown with other minerals. Because of the fine-grained nature of the rock, the great variety of mineral types involved, and the fact that much of the manganese is present in phases from which it is not easily recoverable creates problems both for chemical and physical separation methods. It would seem that a better understanding of these two deposits, especially the positions and extent of the various manganese-bearing phases would greatly aid in the processing problem, as well as recovery.

RPC also has a contract with Supply and Services Canada to study the mineralogy and geochemistry of the N.B. potash deposits. The contract which is administered by CANMET is part of the Canada-New Brunswick MDA. The study involves the potash deposits and the mill circuits. Approximately 100 samples have been collected from the Potash Company of America (PCA) mine and the Denison-Potacan mine which are located in the Sussex area. Samples were selected from the potash ore, the enclosing rocks, potash-barren zones, salt horsts, drill core, and the PCA mill circuit. Thin sections have been prepared and chemical analyses have been completed for the ore samples. The mill samples were taken in order to evaluate the performance of the mill circuit. Grain size, liberation, and chemical composition will be determined in order to establish a mill balance. The project is expected to be completed in mid-1988.

Enhanced Recovery Systems Limited (ERS), a wholly owned subsidiary of RPC, was contracted for $22.35 million under a General Development Agreement between the Government of the Province of New Brunswick and the Government of Canada to acquire, construct, and operate all phases of a 10 t/day pilot plant to demonstrate the technical and economic feasibility of the RPC Sulphation Roast Process. Construction of the plant was completed in April 1985 and operator training, plant commissioning, and preliminary testing took place through to May 1986. Two fully integrated runs were completed successfully in July and August 1986, during which time a comprehensive sampling campaign was carried out for plant balance. Plant cleanup in preparation for the Care and Maintenance phase of the project was completed in October 1986. Final reports encompassing the 10 t/day pilot plant technical, and commercial scale preliminary engineering design and economic feasibility will be completed by March 1987.